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# ANNALS of SURGERY

## A Monthly Review of Surgical Science and Practice

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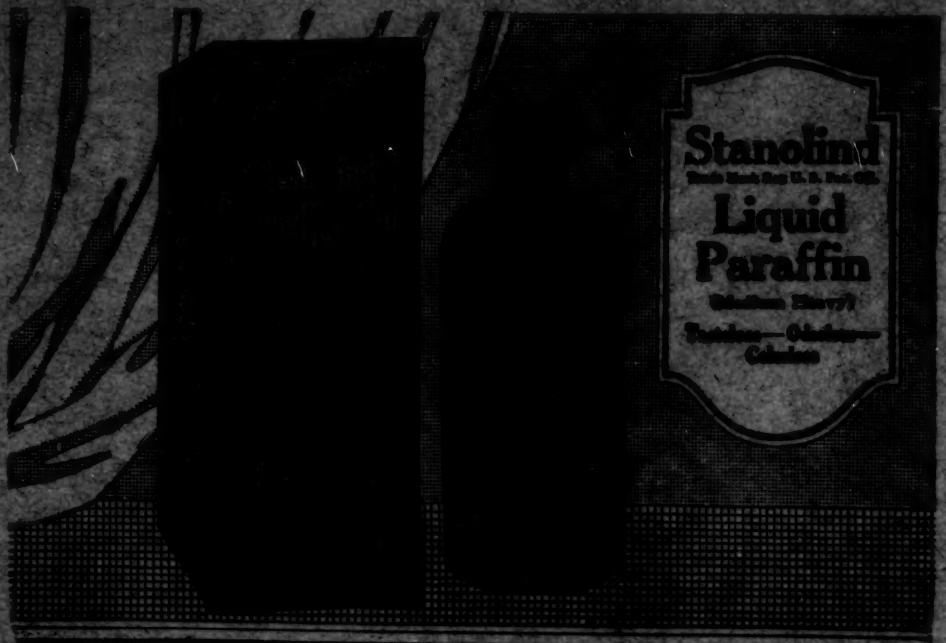


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ANNALS *of* SURGERY

VOL. LXVI NOVEMBER, 1917 No. 5

# THE TREATMENT OF STAPHYLOCOCCUS SEPTICÆMIA BY TRANSFUSION OF IMMUNE BLOOD

BY RANSOM S. HOOKER, M.D.

OF NEW YORK

ASSOCIATE SURGEON, BELLEVUE HOSPITAL, N. Y.

THE performance of blood transfusion has been greatly extended during the past four years. Reports in the literature covering this period show that it has been resorted to as a therapeutic measure for many and varied pathological conditions. Since 1912 I have been associated with Dr. H. S. Satterlee, at first in experimental and technical studies of blood transfusion, and later in the clinical employment of the operation.

Early in this work it became apparent that the use of specially immunized donors, in conditions of bacterial infections and other definitely toxic disturbances, would be a most desirable procedure from a theoretical standpoint. Our first opportunity to test the practical application of this idea was in April, 1913, and we reported the case in January of the following year.[1] Since that time there have been a few cases reported of transfusion of immune blood for typhoid fever, tuberculosis and streptococcus septicæmia, but I have not been able to find any reports of the transfusion of immune blood for staphylococcus infection. As we have had in our series five cases of transfusion for this condition, in four of which we have immunized the donors, I believe the group is of sufficient interest to report, although the number is not large enough to justify important conclusions.

Briefly summarized the cases were as follows:

(*a*) There were two hospital cases, both chronic staphylococcus infections accompanying a long-standing condition of multiple suppurative osteomyelitis and resulting in general sepsis, progressive anæmia and failing resistance.

(*b*) The other three cases were all seen in private practice and were general bacteræmias developing rapidly from localized acute suppurative processes.

In all five of these cases the patients were so ill at the time transfusion was proposed that the outlook was considered well-nigh hope-

[1] Arch. Int. Med., 1914, xiii, 71.

less and transfusion was resorted to as the only available chance of avoiding a fatal issue. The two chronic cases made a complete recovery. One of the acute cases, an osteomyelitis of the tibia and radius, made an immediate and uneventful recovery; the other two acute cases, both affections of the face with bony involvement, improved in a most striking manner but died suddenly, while seemingly convalescent, from cerebral embolism on the eighth and eighteenth days, respectively, following their last transfusion. One of the series was transfused from a non-immunized donor. The other four were transfused with blood from donors who had been subjected to varying degrees of immunization with vaccines derived from the patient's infecting organism.

The cases in detail are as follows:

CASE I.—Boy, E. M., eleven years nine months old, admitted to Bellevue Hospital December 2, 1912.

*Family History.*—Negative.

*Previous History.*—Negative.

*Present Illness.*—Five days ago, after playing out of doors, he came home with headache, vomited and had high fever with delirium. Two days later he developed a pain in the right leg and thigh and was taken to hospital with diagnosis of typhoid fever.

*Physical Examination on Admission.*—Patient in somnolent, semidelirious condition, with eyes closed and every appearance of an acute toxæmia. Routine physical examination revealed nothing except a slight general enlargement of the lymph-nodes, a few fine petechial spots over the abdomen and back and a very swollen and tender left leg from the hip-joint to below the knee, the circumference being nearly twice that of the opposite side. No fracture or deformity of the femur was made out.

*Course.*—The day following admission the lower third of the left femur was opened and pus was found, which yielded staphylococcus aureus on culture. Three weeks later, December 23, the lower and the middle thirds of the bone were opened. On December 28, a similar condition developed at the inner end of the left clavicle and was opened, and on January 5 the inner end of the right clavicle was opened. On this date pus from both clavicles showed staphylococcus aureus. On January 13 blood culture showed staphylococcus aureus and the picture became one of general sepsis with pyæmic foci. In February vaccines were made from the femoral pus and administered to the patient without improvement; in fact the patient became worse and developed additional foci in the left elbow and in the distal phalanx of a finger.

On March 31 the outlook seemed so hopeless that it was decided to try the effect of transfusion from an immunized donor. The blood of an uncle of the boy was found compatible and he was vaccinated with progressively increasing doses of a fresh

vaccine made from the infecting oganism (pus from femur). Vaccination of the prospective donor was continued throughout April.

On April 18, X-ray plates showed fracture of the left femur and osteomyelitis of the entire shaft. On April 28 the patient seemed to be failing rapidly. There were albumin and waxy casts in the urine and the hæmoglobin was 30 per cent. On April 29 a transfusion of 100 c.c. was performed from the immunized donor and the bone sinuses were packed with gauze saturated with the donor's blood. There followed a rapid improvement in the boy's condition and ten days after the transfusion the hæmoglobin had risen to 80 per cent. Shortly afterwards the patient had gained so much in weight and in strength that he was able to wheel himself about in a chair. After a somewhat tedious convalescence, due to the multiple bone sinuses, he was discharged cured on November 28.

CASE II.—Boy, B. K., nine years old, Tuxedo Hospital, Tuxedo, N. Y. Seen in consultation January 13, 1915.

*History.*—The patient had been ill in the hospital for about one year with staphylococcus septicæmia. During that time he had osteomyelitis of both femurs and right ulna, and had several operations upon these bones. Cultures had been taken from all points of infection and staphylococcus aureus had been found in all, but no blood culture had been made. For the past three weeks he had been running an evening temperature of 101°–104° F. and had an apparently increasing general sepsis. There was extensive involvement of the shaft and head of the right femur extending into the hip-joint. The condition was so desperate that transfusion seemed advisable to prepare the patient to stand the shock of a proposed amputation of the right leg at the hip. The leucocytes were 20,000, polynuclears 99 per cent., hæmoglobin 30 per cent., temperature 105° F., pulse 178 and of poor quality. Hæmolysis and agglutination tests of the blood of the patient's sister were found satisfactory. A transfusion was done at once, the sister serving as donor. Five hundred cubic centimetres of blood were given. After transfusion there was so much immediate improvement that it was decided not to amputate, but to hope for some permanently beneficial effect from the transfusion and to immunize the sister for a later transfusion. The patient's condition remained most serious for about ten days, when a gradual improvement began and the sister declined to serve again as donor. The improvement continued steadily, nevertheless, until he was discharged from the hospital the following August, with all sinuses closed. He remained well until January, 1916, when he contracted measles and died of a complicating pneumonia.

CASE III.—Boy, F. P., four years old. Family and previous history negative. Perfectly well up to April 6, 1915, when it was noticed in the morning that he had some blisters on the palm

of the right hand and some soreness about two of the finger nails. Temperature 102° F.

April 7: When seen in the afternoon by a general surgeon there appeared to be a beginning paronychia of the little and ring fingers of the right hand, and there were one or two blebs on the palm. The temperature had risen to 103.8° F. and the boy looked sick. A wet dressing was applied. That night he became wildly delirious and when seen the next morning he seemed sicker, and a superficial infection of the left little toe was found. The urine continued with a heavy trace of albumin and casts. Blood count showed 23,000 leucocytes and 82 per cent. polynuclears. A culture was made of the serum from the blebs and also a blood culture. Temperature, A.M., 103.8°; P.M., 99°.

April 8: Very delirious most of the time. Morning temperature 103.8°; evening temperature 101.2°. There was a tender spot over the head of the left tibia which was incised under cocaine. Some serum was found in the overlying tissues; the bone and periosteum both appeared normal. The second toe of the right foot began to show a superficial infection and was incised but contained no serum.

April 9: Condition the same. Temperature 102.4° in the morning, 103.4° at night. Blood culture of April 7 showed staphylococcus aureus and there was a growth of the same organism from the culture of the bleb serum.

April 10: Some thickening was noticed of the left lower radius. The urine contained blood and 12 per cent. of albumin by volume. There was a slight systolic murmur over the base of the heart. Patient continued delirious and had a morning temperature of 103.8°, with remission to 100° in the afternoon. The father of the boy was given two 50-million doses of a vaccine made from the blood culture.

April 11: The father was given a third dose of 100 million of the vaccine and the patient was prepared for operation, the intention being to give the transfusion simultaneously or immediately following. Under ether anæsthesia the left radius and right tibia were opened and pus was found in both. The patient went into collapse on the operating table and the transfusion was done at once. Three hundred cubic centimetres of blood was transfused and there followed a marked immediate improvement in the condition of the patient. During the day another toe infection was noticed and that night it was discovered that there was swelling and tenderness of the right side of the scalp.

*Subsequent Course.*—There was a definite and progressive improvement of all symptoms during the forty-eight hours following the transfusion, so that it was thought unnecessary to repeat it, although the vaccination of the father had been continued. On the eleventh day of illness, and five days after transfusion, the patient was thought to be out of danger; on the sixteenth day the temperature reached normal and he was allowed

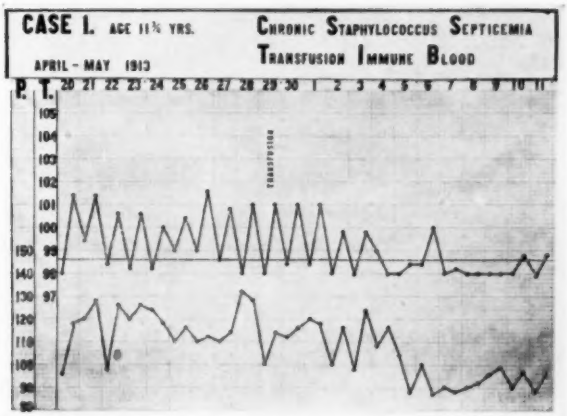


FIG. 1.

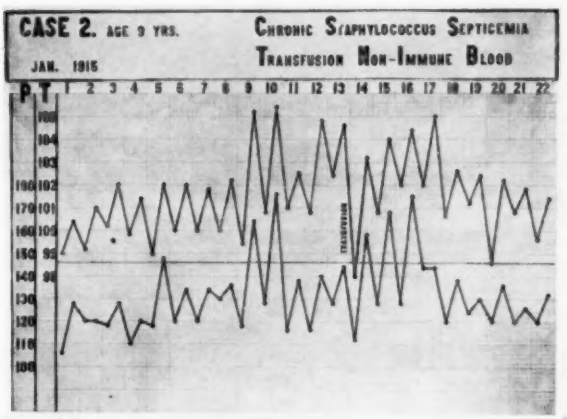


FIG. 2.

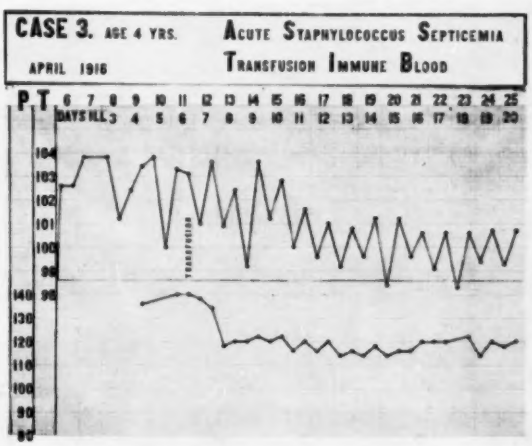


FIG. 3.

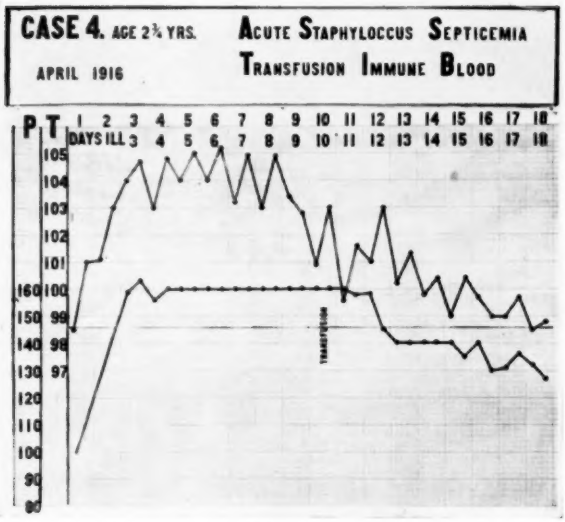
CASE 4. AGE 2¾ YRS.
APRIL 1916
ACUTE STAPHYLOCCUS SEPTICEMIA
TRANSFUSION IMMUNE BLOOD
P T
DAYS ILL
TRANSFUSION

FIG. 4.

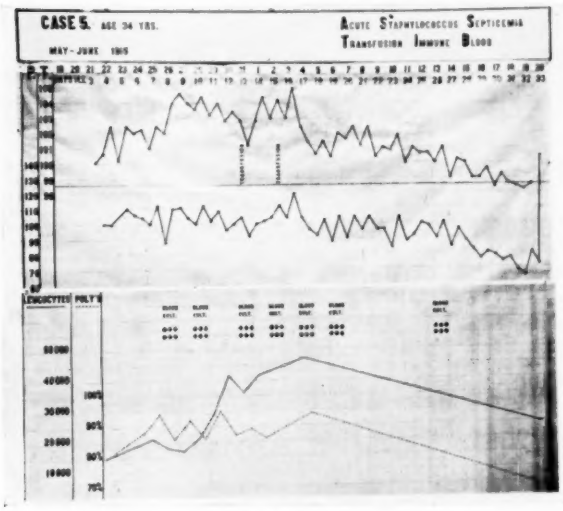
CASE 5. AGE 34 YRS.
MAY-JUNE 1915
ACUTE STAPHYLOCCUS SEPTICEMIA
TRANSFUSION IMMUNE BLOOD
LEUCOCYTES
POLY'S

FIG. 5.

to sit up in bed. The bone sinuses were all closed by the middle of June. On July 6 a sequestrum was removed from the left radius. Several times subsequently the sinuses opened and discharged slightly. At the time of writing (March, 1917) they had been closed for eight months and the X-ray plates show an apparently healthy bone structure.

CASE IV.—Girl, E. M., two years ten months old. Family and previous history negative. On April 1, 1916, a coryza developed. During the next three days the face began to swell and the child seemed to become rapidly septic with gradually ascending temperature.

April 4: Leucocytes 20,600, polynuclears 84 per cent. Urine showed albumin and casts.

April 5: Leucocytes 18,500, polynuclears 80 per cent. Blood culture was made. The face was much swollen and the temperature had reached 105°. A rhinologist saw the child in consultation and punctured the left antrum, evacuating some pus which on culture showed staphylococcus aureus.

April 6: Blood culture of previous day showed staphylococcus aureus, and a vaccine was made from which the patient's father received an initial dose of 50 million. The patient had signs of a beginning pneumonia of the left lower lobe which subsequently developed into signs of consolidation.

April 7: A subperiosteal abscess was discovered above the left upper incisor teeth and this was opened. Culture from this abscess yielded staphylococcus aureus. There was also a cellulitis of the surrounding tissues on the left side of the face. Signs of an effusion appeared in the pericardium and also in both pleural cavities. The father received a dose of 100 million vaccines in the morning and another of 200 million twelve hours later. Transfusion was considered at this time, but the heart's action was so poor that it was deemed wiser to postpone it.

April 8: Patient's condition the same. The father was given a fourth dose of 250 million vaccines.

April 9: Signs of beginning resolution left lower lobe. Apparent increase in chest and pericardial fluid. The father was given a fifth dose of 400 million vaccines.

April 10: The patient became much weaker and transfusion was done, 125 c.c. of the father's blood being given.

April 11: Condition much improved.

*Subsequent History.*—From April 12 to 18 the child improved steadily with a gradual subsidence of the temperature and pulse rate. During this time the signs over the lungs and heart indicated a diminution of the pleuritic and pericardial effusion, although the rate of respiration continued high. On April 18 the temperature reached normal in the morning and all day the child seemed in better general condition than at any previous time of her illness. At 11 o'clock at night she suddenly died, apparently from cerebral embolism. No autopsy was allowed, but imme-

diately after death the pleural and pericardial cavities were aspirated and pus was obtained from all. Differential cell count of the pericardial fluid showed 95 per cent. of polynuclear leucocytes with many intracellular staphylococci. The fluid from the pleural cavities showed 100 per cent. polynuclears, also with many intracellular staphylococci.

Case V.—Man, L. G., aged thirty-four. On May 19, 1915, the patient had been in perfect health, but noticed a small boil on the inside and front of the left nostril. He consulted a rhinologist, who opened it at his office. The next day the pain and extent of the inflammation had increased and there was considerable induration. On May 21 the whole nose and upper face was swollen with an increased area of redness and brawny induration. The opening in the nostril was enlarged. It was thought that he was developing erysipelas and he was sent to St. Luke's Hospital.

May 22: On admission to the hospital his leucocytes were 15,000, polynuclears 82 per cent.; the urine was normal. For the next three days his condition remained about the same with an afternoon temperature of a little over 102° F. The leucocytes increased to 20,500 and the polynuclears to 94 per cent. and the urine began to show albumin and casts.

May 26: A culture from the discharging sinus in the nose showed staphylococcus aureus and a blood culture taken on the same day gave a growth of staphylococcus aureus in small numbers on plates, but the broth cultures were negative. The temperature rose in the afternoon to 104° F. and for nine days following remained nearly at that elevation. The patient appeared generally septic and the prognosis became very grave. There was alternating delirium and stupor and a constantly increasing leucocyte count, as shown on the chart (Fig. 5). Blood cultures showed an increasing bacteriæmia. Two brothers were found to have blood compatible for transfusion and both were immunized with vaccines derived from the organism found in the patient's blood. Locally the infection had spread to the orbit of the left side and this required surgical treatment. Pus from the eye gave a growth of staphylococcus aureus.

May 31: The thirteenth day of illness, the patient was in a very alarming condition with active delirium and occasional periods of stupor from which it was difficult to arouse him. He was given his first transfusion that day—300 c.c. of blood from one of his brothers who had received four doses of vaccines. About 150 c.c. of the patient's blood was taken off as a preliminary.

June 1: The day following the first transfusion, there was very little change.

On June 2 a blood culture was taken and this subsequently showed very marked diminution in the bacteria content as compared with that which had been taken the day before transfusion.

A second transfusion was given that afternoon of 250 c.c. from the same brother. The next day, June 3, the patient showed improvement, especially in his mental condition, but the temperature went to 105° in the afternoon.

On June 4 the temperature dropped to below 102°, the pulse from 120 to 96, and there was a very marked amelioration of all symptoms. The leucocytes on this day reached 47,000, the highest count which had been obtained, and blood culture showed a growth in only one flask, and on none of the plates after six days.

On June 6 another blood culture was made and this developed only a single colony on one plate and nothing in the broth flasks.

Blood cultures taken on June 12 and 13 proved absolutely negative.

June 14: The temperature reached 99°, and the pulse 80. The patient was allowed to sit up in bed and he was thought to be making a rapid convalescence. Everything continued to improve without interruption for the next five days and the patient was allowed to sit in a chair and to move to a lounge from his bed.

One June 20, at 8.10 A.M., he was feeling perfectly well with a pulse of 72. Twenty minutes later he complained of pain in his head, his pulse was 144, his respiration became rapid and shallow. Blood-pressure was 210 mm. Hg. Fifteen minutes later he lapsed into unconsciousness and died. No autopsy was allowed.

*Summary and Discussion.*—After reviewing these case histories from a critical standpoint there are certain indications for management and factors of judgment which assume a collective importance in the retrospect which was not perhaps sufficiently evident at the time of occurrence. It seems worth while, therefore, to summarize the experience which has been gained from this broader view.

In Cases I, II and III it would have been valuable to have followed the bacteria content of the blood after the first transfusion and to have repeated transfusion within a few days if there were not a prompt diminution or cessation of the bacteræmia; and this, I believe, should be a general rule in all cases.

Case II illustrates a point which it is important not to forget when considering the indications for transfusion in such conditions, and that is that there is almost always a pronounced secondary anæmia and that normal resistance to infection is very much impaired by this alone. Transfusion of normal blood is therefore of assistance in combating the infection by simply correcting the anæmia and thus helping to restore normal resistance.

In Case III transfusion should have been done earlier with non-immune blood if necessary, and a second transfusion with immune blood could have followed. In all three cases there was, notwithstand-

ing these seeming errors of judgment, a favorable outcome definitely attributable to the transfusion.

In Case IV the toxæmia, and presumably the bacteræmia, was favorably influenced by the transfusion, but it is to be regretted that the transfusion was not given earlier and repeated according to indications. How far phagocytosis was influenced by transfusion in this case would have been an interesting study and might have had special prognostic significance in view of the extensive exudation into the pleural and pericardial sacs. What would have been the outcome in this case if death had not come suddenly from embolism is hard to conjecture.

In Case V the progress of the system infection and reaction against it is fairly well shown on the chart by the leucocyte curves and the blood culture findings. The striking improvement in the whole clinical picture left little room to doubt that the transfusions were the deciding influence in changing a hopeless prognosis into a confident expectation of recovery.

Embolism from septic thrombi is probably an unavoidable danger in the course of, and during, recovery from any bacterial infection of the blood, but is particularly apt to occur with primary infections of the face and of the orbital, nasal and oral cavities.

## CONCLUSIONS

*Chronic Infections.*—The general conclusion to be drawn from a study of the experiences which have been here related is decidedly in favor of the efficacy of immunized blood transfusion in chronic staphylococcus septicæmias, and especially in those which complicate bone conditions. This conclusion would seem applicable to any delayed recovery from severe staphylococcus infection where the resistance is lessening and is likely to be non-responsive to active immunization by vaccines.

Another interesting and as yet unreported case, which falls into this category, is one which has been recently brought to my attention by Dr. K. M. Vogel, having occurred last December in his service at St. Luke's Hospital. This patient developed a staphylococcus bacteræmia on the thirty-seventh day of typhoid fever and was in a very serious condition for fifteen days following. She was transfused three times with staphylococcus immune blood, on the fifty-second, the sixty-fifth and the eightieth days of her illness. There was an apparently favorable response to each transfusion and the patient made an uninterrupted recovery.

In this class of cases there is usually ample time to prepare a suitable donor by administration of vaccines, but if the anæmia is pronounced no time should be lost in performing a preliminary transfusion of normal blood.

*Acute Infections.*—Early blood cultures and an immediate start to immunize a donor are of the utmost importance in these cases. If urgent, it is best not to wait for full immunization but to give the first transfusion even after one dose of vaccines. The effects of transfusion by study of blood counts, blood cultures and general symptoms should be observed and the operation repeated as indications arise, being mainly guided by the bacteræmia. If the patient has a fairly good blood volume with a high bacterial blood content, there should be no hesitation in removing a considerable amount of blood by venesection just before transfusion.

*Special Results From This Study.*—During the study of these cases it has repeatedly occurred to us that it would be a great advantage if there were some practical way in which the patient's blood might be tested for its inhibiting action on the growth of the infecting organism and for its opsonic power; and that the blood of various donors might also advantageously be so tested and compared, especially when there is little time for immunization of the donors by vaccines. This would not only show a possible preference in natural immunity towards staphylococcus possessed by different donors, but it would afford a criterion of the desirability of removing some of the patient's blood before transfusion in the event of its showing a low index of immunity, thus permitting the transfusion of a greater volume of blood from the donor.

A careful opsonic determination of the patient's blood and of that of different donors by the method of Neufeld, or the employment of a complement-fixation method to determine antibodies might accomplish such a purpose. But neither of these alternatives is easily applicable and both are too slow to satisfy the urgent need of quick findings.

What promises to be a much more practical way of getting the desired information in a short space of time has been suggested to us by Dr. Hans Zinsser, and that is, a method of specific protection on mice. The laboratory details of such a method we hope to work out in the near future under Dr. Zinsser's direction.

# PERSISTENCE OF BACTERIA WITHIN SEQUESTRA

By Captain Kenneth Taylor, U.S.R.

and

Mary Davies

of Paris, France

(From the Laboratories of the Robert Walton Goelet Research Fund, American Red Cross Hospital of Paris)

The treatment of the old suppurating fracture, resulting from a shell or rifle-ball wound, offers one of the most difficult problems in the base hospital. Perhaps no other form of injury withholds from active service such a large number of men for such a long period of time. For this reason it seems advisable to publish the incomplete data so far at hand resulting from investigation of the bacterial flora of these wounds. These data include observations on the persistence of various bacteria within the wounds and especially within the bone itself; the recrudescence of infection following operations on a septic field, commonly called a "flare;" the possible reaction of anaërobic bacilli to this recrudescence of infection.

It is difficult to get an accurate idea of the bacteria persisting in the suppurating fracture. Many bacteria, especially the anaërobes, are found in a low state of vegetative activity, so that cultures frequently show only the growth of the more active aërobic or facultative flora. A long period of incubation, usually a week or ten days, is necessary for the development of some of the spore-bearing anaërobes.

For this study sequestra from a continuous series of secondary operations on suppurating compound fractures were examined. The cases were chiefly fractures of the long bones which had reached the stage of bone sinuses, or, in two instances, were completely closed but showed sequestra on X-ray examination. They varied in age from forty-five days to three hundred days. In the majority of cases the specimen examined was removed at operation about one hundred and thirty days after the original injury. They varied in size from a few millimetres to several centimetres in diameter. The cultural technic was as follows:

*Method of Examination.*—In order to determine if there were any difference between the flora of the wound itself and the flora within the sequestrum the following technic was employed. To determine the flora of the wound the sequestrum was placed into sterile saline solution and well shaken. The resulting *emulsion* was inoculated into deep agar, upon agar plates, into anaërobic broth, into meat culture medium and into milk. To determine the flora within the sequestrum the sequestrum was removed from the saline emulsion, dried, and sterilized by being dipped into alcohol and flamed, this procedure being considered adequate to destroy most of the

organisms present outside the bone. The sequestrum was then inoculated into deep agar or meat. Afterwards it was removed from the culture tube, decalcified, sectioned and studied histologically.

*Distribution of Bacteria.*—Both the emulsion containing the flora of the wound and the interior of the sequestrum showed a large and varied flora. Streptococci, staphylococcic, diphtheroid bacilli, the B. pyocyaneus, Colon bacilli, the B. proteus, the B. aërogenes capsulatus, the B. malignans œdematis, the Hibler bacillus No. IX types were among those most frequently found both in the emulsion and in the sequestrum.

In about 90 per cent. of the specimens of bone examined histologically, bacteria were seen lying well within the substance of the sequestrum, usually in nests within the canals or cell spaces.

It was observed that certain organisms were obtained more frequently from the interior of the sequestrum than from the emulsion containing the wound flora. Table I shows a comparison of the flora derived from the two sources. It was found to be impossible in the time available to identify the species of all the bacteria recovered from each case. They were therefore classified in the following groups: Aërobes: staphylococci, streptococci, small Gram-negative bacilli, small Gram-positive bacilli; anaërobes: gas-forming organisms and spore-bearers. The table shows the percentage incidence of each group of organism recovered from the wound and from within the sequestra of 48 consecutive cases.

TABLE I

PERCENTAGE INCIDENCE OF VARIOUS GROUPS OF BACTERIA IN WOUND AND IN SEQUESTRUM FROM 48 CONSECUTIVE CASES

| | Aërobes | | | | Anaërobes | |
|---|---|---|---|---|---|---|
| Group of organisms | Staphylococcus | Streptococcus | Small Gram-negative bacilli | Small Gram-positive bacilli | Gas-forming bacilli | Spores |
| Wound..... | 52 | 66 | 60 | 42 | 14 | 7 |
| Sequestrum..... | 62 | 80 | 74 | 53 | 55 | 42 |

It may be noted that each group of organisms was recovered more frequently from the sequestrum than from the wound, suggesting a richer flora within the former. One point, however, is especially evident, and that is the greater incidence of the anaërobic group within the sequestrum. Gas-forming anaërobes developed nearly four times more often from the bone than from the wound, while spores were present six times more often. In no case were gas or spore-producing anaërobes recovered from the wound when not recovered from the sequestrum removed from it. *The bone itself appears to be the most common site for the persistence of the anaërobic flora.*

It is interesting to divide the 48 cases according to the age of the wound. When those from which the sequestra were removed within 120 days of the injury (numbering 22) are compared with those which varied in age from 120 to 300 days (numbering 26), as in Table II, one variable feature may

be remarked. The flora recovered both from the wound and from the bone showed a much higher incidence of anaërobes in the older cases than in the newer. The aërobic flora from both wound and bone showed no great variation in the two groups of cases, except that the incidence of staphylococci was higher and that of streptococci lower in the old cases than in the new. The occurrence of flares, which is discussed later, is added to the table.

TABLE II

PERCENTAGE INCIDENCE OF VARIOUS GROUPS OF BACTERIA IN WOUNDS AND SEQUESTRA IN EARLY AND LATE CASES

| Group of organisms | Wound | | | | | | Sequestrum | | | | | | Flares |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aërobes | | | | Anaërobes | | Aërobes | | | | Anaërobes | | |
| | Staphylococcus | Streptococcus | Small Gram-negative bacilli | Small Gram-positive bacilli | Gas-forming bacilli | Spores | Staphylococcus | Streptococcus | Small Gram-negative bacilli | Small Gram-positive bacilli | Gas-forming bacilli | Spores | Per cent. of cases |
| 22 cases, less than 120 days | 45 | 77 | 64 | 36 | 9 | 0 | 45 | 86 | 77 | 50 | 45 | 27 | 32 |
| 26 cases, more than 120 days | 58 | 62 | 58 | 50 | 15 | 15 | 73 | 77 | 69 | 54 | 65 | 42 | 58 |

## CAUSES OF PERSISTENCE WITHIN SEQUESTRA

*Structure of Bone.*—The persistence of bacteria for such a long period within the bone is probably due to the mechanical protection afforded by the dense structure of the bone itself for organisms present within its spaces and canaliculi. There they are well protected from the body fluids and phagocytic cells. Leucocytes were very rarely seen within the bone in any of the sequestra sectioned.

Furthermore, the bacteria are protected from any antiseptic which may be introduced into the wound. A few attempts to sterilize bone sequestra *in vitro* by strong antiseptics were sufficient to demonstrate the improbability of accomplishing this result within the wound. Small splinters of only a few millimetres in diameter may be soaked in alcohol 75 per cent., hydrogen peroxide, Dakin's solution, bichloride of mercury 1–10,000, 5 per cent. carbolic acid or tincture of iodine, for half an hour or more and a good growth of organisms obtained after breaking and resowing the splinter into a suitable medium.

*Alkaline Salts of Bone.*—There is another factor which may favor the persistence of bacteria within bone. It is recognized that to secure a long-continued growth of bacteria in artificial media the life of certain acid-producing organisms may be greatly extended by the addition of chalk to the medium to prevent the accumulation of some of the acid products and the consequent autogenous sterilization of the organism. The conditions about the organism within the bone may be compared to the environment of those grown *in vitro* in the chalk tubes. It seems probable that the insoluble bone

salts may combine with the acids produced during the growth of the bacteria and thus remove by-products which usually tend to limit their growth. At the same time this reaction will result in a loss of substance on the part of the sequestrum.

*Erosive Action of Bacteria on Sequestra.—In vitro* experiments on the action of various organisms on sterilized and thoroughly dried pieces of beef bone were conducted to determine how the loss in weight varied with different organisms. Small pieces of compact bone, weighing approximately half a gramme, were incubated in a meat culture of the gas bacillus, the B. malignans œdematis, the Hibler bacillus No. IX, the B. proteus, Staphylococcus aureus, or Streptococcus pyogenes for a period of ten days. After this period the bones were removed, washed thoroughly, dried, as before, in a dry sterilizer, and weighed. The results of several experiments were fairly consistent. The Hibler bacillus usually produced the greatest loss in weight (approximately 8 per cent. of the previous dry weight). The gas bacillus and the B. malignans œdematis caused a loss of about 6 per cent. in the same period of time, while the bones incubated with the streptococcus and the B. proteus usually lost less than 3½ per cent. Staphylococcus proved the least active of all, never producing more than 2 per cent. loss—no more than that of the uninoculated control. Part of this loss in weight may have been due to the digestion of the small part of protein material present even in compact bone, but since the same pieces of bone were used for two and sometimes three successive experiments, and the loss in weight continued to occur at about the same ratio, the loss due to the digestion of the soft constituents must have been only a small fraction of the total.

*Erosive Action of Certain Organic Acids on Sequestra.*—Since some organisms produce considerable quantities of organic acids in the process of growth, the loss in the weight of the bone due to the solvent action of some of these acids was compared with the loss due to the action of the bacteria. Specimens of bone were placed in 1 per cent. solutions of acetic, propionic or butyric acids and incubated for ten days, the same time as the bacterial cultures. The specimens from the acetic tubes showed an average loss during this period of about 14 per cent.; those from the propionic tubes an average of about 11 per cent.; those from the butyric tubes an average of 7.1 per cent.—slightly more than the average loss from the action of the B. aërogenes capsulatus. The controls in distilled water lost from 2 per cent. to 3 per cent. These three acids are probably produced during the action of some anaërobes (for example, the gas bacillus) upon meat. It is possible that the erosion of the bone is due to these substances.

Therefore, although it would appear to be impossible to sterilize bone sinuses by antiseptics, the erosive action of acids may be utilized in a dressing solution. The use of a solution such as 1 per cent. acetic acid may hasten the disappearance of the sequestra and so destroy the focus of infection.

*Bone Sinuses.*—The presence of organisms within the dead bone (whether in sequestra or in portions still attached to living bone), rather than in the soft tissues, is probably the cause of the persistence of the sinus and the

occurrence of the acute recrudescences of infection, or " flares," after secondary operative procedures. By the gradual erosion of a sequestrum at the bottom of the bone sinus, as well as by the outgrowth of bacteria from this nidus of infection, continual reinfection of the sinus tract must occur. The closing of the sinus cannot be accepted, however, as proof that the sequestra have disappeared and the bone become sterile. Growth was obtained from sequestra removed from two cases in which the sinus had been completely closed for two weeks or more. This persistence of bacteria shows the necessity of caution in undertaking at an early date operations, such as bone grafting or nerve suture, where asepsis is a primary necessity.

It should be remembered that the sequestra form only a portion of the dead and infected bone present about the fracture. Many small devitalized portions which have not yet become detached from the living bone are probably heavily infected and are undergoing the same process of erosion as the sequestra themselves. This is the probable source of the infection which is one of the causes of failure in the grafting of bone upon old fractures.

*Flares.*—The cases classified as " flares " have been those which showed a rise of temperature within 24 hours of the operation (sequestrectomy), amounting to one degree or more of fever, continuing for 48 hours or longer and associated with a local inflammatory reaction about the wound. This reaction may probably be regarded as evidence of a temporary acceleration of growth on the part of the organisms freed by the crushing of bone and callus incident to the operation, and the absorption of the toxic products of their growth in the blood and serum left in the fresh operative wound. Absorption is, of course, facilitated by the operative trauma to the soft tissues.

About 39 per cent. of the 48 cases studied in this series showed the reaction defined as a " flare." Nearly twice as many flares occurred in the older cases as in the newer, as represented by a percentage of 58 in the cases of more than 120 days as against 32 in the cases of less than 120 days (Table II). It is possible that the older cases were originally of a more severe type, although this could not be substantiated by an examination of the histories. The older cases may have become more delicately sensitized to the proteins of the bacteria infecting the wounds, and the temperature reaction may have been of an anaphylactic character rather than a direct toxic reaction. This, however, seems improbable, since the majority of the cases ran a temperature course lasting several days and usually giving *local* symptoms of a renewed acute infection. The reaction cannot be satisfactorily explained by any difference in post-operative treatment or lack of treatment. All the cases were placed immediately after operation either upon the Carrel-Dakin technic or upon simple dry dressings. A much higher percentage (88.5 per cent. as against 40.6 per cent.) of those on the Carrel-Dakin technic showed the flare reaction than those on dry dressings.

Table III shows a comparison of the flare cases and those showing the normal reaction after operation. The great preponderance of the anaërobic flora of the bone in the flare cases is apparent.

TABLE III

PERCENTAGE INCIDENCE OF VARIOUS GROUPS OF BACTERIA IN SEQUESTRA OF NORMAL AND "FLARE" CASES

| Group of organisms | Aërobes | | | | Anaërobes | |
|---|---|---|---|---|---|---|
| | Staphylococcus | Streptococcus | Small Gram-negative bacilli | Small Gram-positive bacilli | Gas-forming bacilli | Spores |
| Normal after operation—26 cases.. | 68 | 86 | 73 | 45 | 40 | 23 |
| Flare after operation—22 cases... | 55 | 75 | 75 | 60 | 70 | 50 |

*Relation of Anaërobes to Flares.*—Now there was a greater proportion of anaërobes in the old cases than in the new, and also a greater number of flares. Were the anaërobes the cause of the flares?

Since the greater incidence of anaërobes in the flare cases might be considered merely an apparent one due to the fact that most of the flares are included in the group of old cases (Table II), it is advisable to consider the groups of old and new cases separately. Table IV shows the flora of the flares and non-flares of each group.

TABLE IV

PERCENTAGE INCIDENCE OF ANAËROBIC BACTERIA IN SEQUESTRA COMPARED AS TO AGE OF CASE AND REACTION AFTER OPERATION

| Reaction | New cases | | Old cases | |
|---|---|---|---|---|
| | Percentage incidence of | | Percentage incidence of | |
| | Gas-forming bacilli | Spores | Gas-forming bacilli | Spores |
| Normal after operation..... | 33 | 13 | 56 | 42 |
| Flare after operation..... | 71 | 57 | 80 | 58 |

It appears from the table that anaërobic gas-producing bacilli and spores occurred much more often in the flare cases than in the non-flare, *independently of the age of the case.* Furthermore, the predominance of anaërobes in the flare cases over that in the non-flares is greater in the group of new cases than in the old.

Three cases were of special interest in respect to the causal relation of the anaërobic flora to the flare. The first case was operated upon twice with an interval of about two weeks. A flare followed both operations and sequestra removed on each occasion showed spores and gas-producing anaërobes. The second case was also subjected to two operations for removal of sequestra at about two weeks' interval. After the first operation no flare occurred, and no gas-producing bacilli or spores were found in the sequestra removed. After the second operation, two weeks later, a sharp flare occurred, and sequestra removed and examined showed spores and gas-producing anaërobes. The third case underwent three operations with intervals of

about ten days between each. No flare followed either of the first two operations, nor were spores or gas-forming bacilli found in the sequestra; but a sharp flare followed the third operation and a heavy growth of gas-forming spore-bearing anaërobes was obtained from the sequestra removed.

## SUMMARY

Aërobic and anaërobic bacteria invade the bony substance of nearly all sequestra and remain there as long as the sequestra persist.

Gas-forming, spore-bearing anaërobic bacilli, usually the B. aërogenes capsulatus, B. malignans œdematis and B. Hibler IX types, persist longer within the bone than in the wound about it. They were never recovered from the wound when absent in the sequestra. Nests of these anaërobes may persist for some time after the wound is completely closed.

Anaërobic bacilli are probably active factors in the disintegration of sequestra within the wound.

Anaërobic bacilli *within* the dead bone appear to be associated with the occurrence of " flares " after operations on bones.

Flares occurred more frequently after sequestrectomy when the cases were over 120 days old than when the cases were under that age.

It is probably impossible to kill by antiseptic treatment the bacteria within the dead bone. The object of treatment must be to remove this focus of infection. The sequestra may be extracted by operation, or their disappearance hastened by utilizing the solvent action of *acid* dressing solutions.

The persistence of bacteria within the bone probably explains the infection which often follows bone grafts in old compound fractures and indicates the advisability of postponing that operation as long as practicable.

We take pleasure in acknowledging our indebtedness to Dr. Joseph A. Blake, Surgeon-in-Chief of the hospital, and to the Surgical Staff for their coöperation with the laboratory in these investigations.

# DIABETES INSIPIDUS AS A SEQUEL TO A GUNSHOT WOUND OF THE HEAD

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The following case is of interest because it seems to bring additional support to the idea that diabetes insipidus is an expression of a disturbance of function of the hypophysis or its neighboring tissue. So far as I have been able to learn from a survey of the literature it is the only case in which the occurrence of marked polyuria without sugar has been observed after a head injury of this type. Doubtless the European war will bring out records of many more cases of a similar nature.

Mr. O., aged forty-six years, was brought to the hospital on March 29, 1916, by Dr. Arneson, of Scarville, Iowa, suffering from a gunshot wound of the right temporal region which had been self-inflicted about fourteen hours previously. An X-ray examination of the head disclosed comminuted fractures of the right temporal and left frontal bones and a bullet lying subcutaneously in the left frontal region. There was such extensive extravasation of blood around both eyes that they could not be opened. There was also bleeding from the mouth and nose. The patient was unconscious, but restless. There was no evidence of paralysis. An immediate operation was performed under light anæsthesia for the purpose of providing adequate drainage of the wounds and of removing the bullet. The total duration of the operation was eighteen minutes. In the twenty-four hours following the operation only 14 ounces (448 c.c.) of urine passed, which were obtained by catheter. On the fourth day the patient became partly rational, and it was discovered at that time that he was totally blind in both eyes, although no lesion of either eye was evident. From then on the total amount of urine passed during the twenty-four hours increased enormously. Because of frequent urinations in the bed, it was impossible to measure accurately the total amount of urine passed on any day. But on April 10, in addition to three urinations of large amounts in bed, 139 ounces (4½ litres) were voided. A sample of this urine showed a slightly acid reaction, a specific gravity of 1002, and no abnormal constituent. On April 12 the amount of urine which could be collected totalled 170 ounces (5½ litres). An analysis of this urine was similar to that of April 10. The enormous polyuria, accompanied by polydipsia, remained a prominent feature of the case until his discharge on April 18. His condition had constantly improved. But his mentality never became normal and his blindness remained complete. He became so unmanageable that he was transferred to the State insane institution at Cherokee, Iowa.

The total blindness which developed following the gunshot wound was almost certainly due to cutting or destruction of both optic nerves. From the direction which the bullet took it is probable that the optic nerves were cut at the chiasm. Such injuries have been repeatedly described in association with gunshot wounds of the temporal regions. Repeated attempts were made by Dr. F. G. Murphy to examine the fundus of the eyes to ascertain the presence of optic nerve atrophy, but the irrational mental condition of the patient made such an examination impossible. A wound sufficiently near the hypophysis to involve the optic chiasm could easily affect the hypophysis, if not at first, at least by subsequent swelling of the parts or a contracture of scar tissue. It seems probable, therefore, that the polyuria was induced by injury to the hypophysis. The fact that it appeared four days after the injury would indicate that the hypophysis had not been injured directly by the bullet, but rather by the reaction which occurred in the region. It has so far been impossible to learn whether the polyuria has persisted.

The discovery by Magnus and Schaefer [1] in 1901 of the diuretic action of a watery extract of the posterior lobe and pars intermedia of the hypophysis directed attention in a striking manner to the relationship which exists between disturbances in that gland and diabetes insipidus. E. Frank [2] in an important article published in 1912 reviewed the literature then existing on the subject and made a strong plea for a consideration of the relationship between the hypophysis and diabetes insipidus. Numerous writers already had emphasized the fact that lesions of the brain which involved the vicinity of the hypophysis were often accompanied by polyuria without sugar. Oppenheim [3] in thirty-six cases of basal syphilitic meningitis observed polyuria in twelve cases. Two of these showed at autopsy a gumma of the optic chiasm and hypophysis. Kruse [4] in a study of thirty cases of bitemporal hemianopsia observed diabetes insipidus in seven; and Spanbock and Steinhaus [5] mention its occurrence in eleven of fifty cases of bitemporal hemianopsia. Polyuria associated with metastatic carcinoma involving the hypophysis or its region, secondary to carcinoma of the breast, is a fairly frequent occurrence. Cases have been reported by Simmonds,[6] Rosenhaupt,[7] Miller,[8] and von Gierke.[9] Recently Sekiguchi [10] has described two additional cases. Cushing's [11] experiments in 1913 led him to conclude that there was a strong "argument in favor of the view that an actual disturbance of the pituitary body itself, rather than the stimulation of some predicated diuretic centre in the remote third ventricle surmounting the growth, was the inciting cause of a condition worthy of the designation of diabetes insipidus." Lewis and Matthews [12] in 1913 concluded from their experiments that diabetes insipidus is probably dependent on the hypersecretion of the diuretic substance of the posterior lobe which is secreted by the epithelial covering known as the pars intermedia. Falta,[13] however, warns against a too hasty conclusion that lesions of the base of the brain which induce polyuria do so always by mediation of the hypophysis, although he discusses at length the possibility that such may be the case.

Several cases of diabetes insipidus of which the onset occurred after a trauma to the head are in the literature. Doubtless, at least a temporary polyuria will be found to be very common after head injuries, especially basal skull fractures, if attention is more frequently directed to the output of urine. Mohr [14] has recorded a case which developed about three weeks after a basal skull fracture, and Kleeblatt [15] described one occurring on the third day after a similar lesion. French and Ticehurst [16] also observed a case of diabetes insipidus which had its origin in a fracture (through the sphenoid).

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# TRAUMATIC BRACHIAL PARALYSIS WITH FLAIL SHOULDER JOINT

WITH A REPORT OF THREE OLD AND ELEVEN NEW CASES

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In a series of papers, published during the past five years, the effort has been made to show that traumatic brachial paralysis may be due to injury of the shoulder joint without actual trauma to the nerves supplying the limb involved. The chief evidence offered consists in the recovery of normal power merely from restoring normal function to the shoulder joint. If the shoulder joint relations are normal, the treatment consists in measures to overcome the limitation of movement always present in the shoulder joint. If the shoulder joint relations are abnormal, the treatment consists first in restoring them to the normal and then restoring the normal motion. The abnormal relations are due to dislocations. In the adult we have to deal usually with the ordinary anterior, subcoracoid dislocation, in the new-born with the posterior subluxation. In adults there occurs, not infrequently, a dislocation in which the humeral head drops below its normal level and the joint usually becomes flail. The purpose of this paper is to confirm, by further clinical experience, the conclusion reached in the first paper[1] on this phase of traumatic brachial paralysis, *i.e.*, that the flail shoulder joint is the result of such a dislocation and is essentially the cause and not the result of the paralysis. This is shown by the fact that the early operative removal of the flail shoulder results in a cure of the paralysis.

While the degree of paralysis and pain has varied considerably in my fourteen cases, one feature has been constant, the falling of the upper end of the humerus from a half to an inch below its normal level under the acromion. One type is more common than the others, although this varies in the degree of paralysis associated. The fingers can be pressed between the head of the humerus and the acromion, but this separation is easily removed by pressure upward under the elbow. As soon as the pressure is removed, however, the relaxed condition of the joint recurs. The patient can, usually, lift the humerus up to its normal level by a little muscular effort, but as soon as this effort is relaxed the humerus falls again. The muscles progressively atrophy until finally the upper end of the humerus may become almost subcutaneous. Usually, the movements and power of the hand are very good and may be almost normal. But the power decreases as the shoulder is approached and there it may be almost nil. In two cases the shoulder joint was tensely filled with effusion and not flail. I have had one case with complete paralysis of the whole limb and one with almost complete paralysis, in both of which

* Read before the Philadelphia Academy of Surgery, May 7, 1917.

[1] The Journ. Nerv. and Ment. Dis., vol. 38, No. 4, April, 1911, p. 193.

there developed a painful stiffness of all the joints of the limb involved. There is reason to suspect that much of the apparent paralysis was due to this pain and limitation of movement of the muscles and joints. Both died within a year and a half after the injury, and at the time of death the paralysis had disappeared in both; the stiffness and pain had improved very much but had not entirely disappeared and was still very severe in the hand.

As already stated the purpose now is not to discuss further the probable mechanism of the joint injury, but to support it by the results of treatment based upon it, and to outline that treatment. A very brief reference to the mechanism is necessary to properly appreciate the purpose of the operation. The most common cause of injury to the shoulder joint is hyperabduction from excessive force in a fall on the hand or grasping some object with the hand to prevent the fall. Rarely the force is sufficient to tear away the capsule and tendinous attachments from the neck of the humerus all around, when from this loss of support the humerus and the rest of the limb may sink downwards until the surrounding attached structures take up the support. The gap intervening between the lacerated surfaces later fills in by cicatricial tissue. While this is taking place this gap is maintained on the upper outer side of the joint where the capsule is under tension, but is not maintained on the axillary side where the torn edges of capsule come together because on this side the capsule is relaxed. This results in a lengthening of the capsule on the upper outer side and a contraction on the inner side. The outer lengthening permits the humeral head to drop when the arm is at the side. Because of the axillary contraction when the arm is carried into abduction the humeral head is forced up firmly to its normal level under the acromion. For the same reason complete abduction is prevented, notwithstanding the flail point. The humeral head probably can never go back to its normal level under the acromion against gravity with the arm at the side, and the patient ever afterwards suffers from the abnormality in the joint. To show the separation between the acromion and upper end of the humerus, the X-ray must be taken with the patient in the upright position. That this joint condition is the cause of the paralysis is proven in recent cases by the fact that when the joint is restored to its normal condition and is used long enough the power returns in the muscles. The normal joint conditions have been restored merely by shortening the upper and outer abnormally lengthened portion of the capsule by means of an operation and afterwards removing the operative stiffening of the joint by proper exercises.

In the shoulder as in most joints, a satisfactory exposure of the capsule without excessive division of muscles is very difficult and will, probably, deter many from trying this method of treatment. I have varied the operation in minor details in the effort to discover the easiest and simplest method, and I am not yet prepared to describe a single operation and exclude the other variations. I have presented a brief outline of each one in the case reports. Unless the surgeon is unusually familiar with the anatomy of the

part, I would advise the operation described in connection with Case IX. The incision follows the McBurney principle and gives a limited exposure of the capsule, but with a little patience and care it is sufficient for the purpose. As no capsule sutures (they are very difficult to introduce) are employed, it will be well to fix the arm after operation in the position shown in Fig. 7 and maintain it there for about five weeks. Unless the patient is willing to persist for a long time after the operation in exercises to force the arm into full abduction and external rotation, as by hanging by the hands, there will be much danger of permanent stiffness of the shoulder joint. Upon the rapidity with which the motion returns and the frequency with which it is used, depends in a large measure the rapidity and completeness with which the power of the muscles return. Yet complete or almost complete return of power seems to be possible when a considerable stiffness of the shoulder becomes permanent, as in Case IX.

CASES PREVIOUSLY REPORTED

CASE I.—Man, thirty-nine years old. April 9, 1909, fell on board ship, a height of 8 ft., on his left side, while under the influence of liquor. Did not notice anything wrong with his shoulder until the following morning when it was stiff and painful. Admitted to the Philadelphia General Hospital April 10, 1909, on the service of Dr. J. Chalmers DaCosta who kindly turned the case over to me. I examined the patient for the first time about six weeks after the accident and found a severe brachial paralysis with flail shoulder, the paralysis being most severe at the shoulder and gradually becoming less toward the hand which was normal. Operation June 4, 1909. Incision along the posterior margin of the deltoid. Distinct evidence of old fractures of greater tuberosity found. Posterior scapular muscles lifted from the capsule, which was incised midway between its glenoid and humeral attachments with overlapping of these margins by catgut sutures. External rotator muscles also shortened by a tuck in each with catgut sutures. Wound closed with temporary drainage for oozing, and arm fixed on splint at right angles with body and in full external rotation. Primary healing. Arm brought to side in two weeks and supported for another week. Massage and exercises to improve motion at shoulder. In three months power of limb and motion at shoulder practically normal, and these have remained normal ever since. This patient has been available for observation almost continuously since the operation, as a fireman at the Philadelphia Hospital. The foreman says this patient is his best workman.

CASE II.—Woman, twenty-five years of age. On December 2, 1910, on taking her seat in a rocking chair, she raised her arms above her head in the act of "stretching," when the chair suddenly tilted backward, necessitating a sudden and vigorous effort to recover her balance. This produced a severe pain which she located in the middle of the arm about over the insertion of the deltoid. A little later she tried flexion and extension of the forearm to "take the catch out of the arm," but without success. She went to the theatre the same

FIG. 1.—Case I. Before operation. Paralyzed left arm shows some atrophy and a slight notch on the point of the shoulder indicating the dropping of the humerus from its normal level under the acromion. Compare with normal right shoulder, and with same shoulder in Fig. 2. *C*, clavicle; *A*, acromion; *S*, abnormal space between humerus and acromion; *H*, head of humerus.

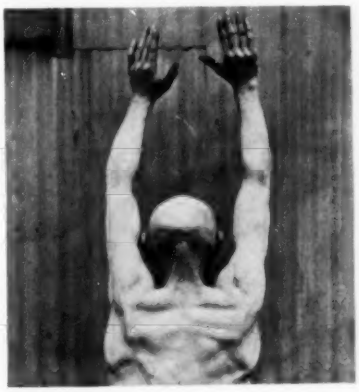

FIG. 2.—Case I. Picture taken in 1914, showing good muscular development of left upper extremity, which is as good to-day.

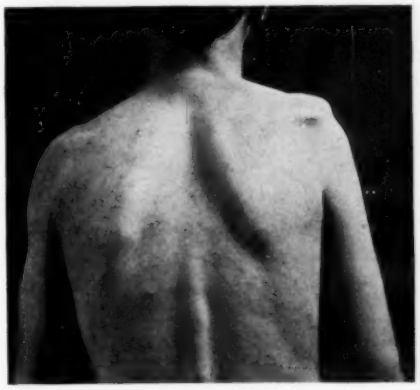

FIG. 3.—Case V. Posterior aspect of shoulder in a typical case of traumatic brachial paralysis with flail shoulder-joint.

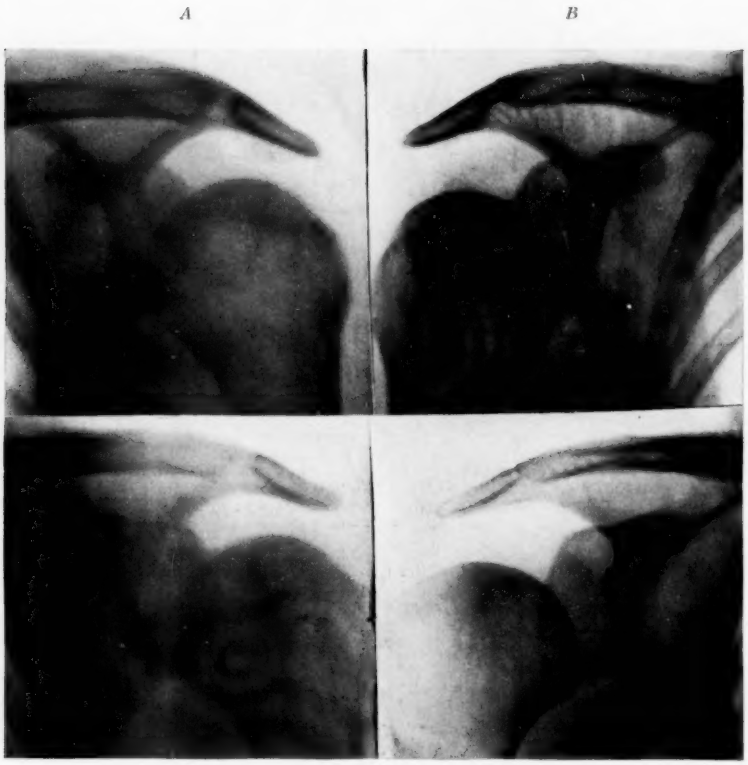


FIG. 4.—Shows that a flail shoulder-joint, once developed, however slight, probably never can fully recover, because the humeral head cannot go back to its normal level against gravity. *A* and *C*, normal right shoulder; *B* and *D*, affected left shoulder. *A* and *B* taken March 4, 1916, about seven and a half months after beginning of trouble. By directing the X-rays in the plane of the acromion process the widest possible space was obtained between the acromion and humeral head, thus emphasizing the difference between the two shoulders. *C* and *D* were taken May 5, 1917, fourteen months after *A* and *B*, the X-rays being directed in the same plane in all four pictures. The left shoulder has lost none of its laxity, which is, probably, permanent.

FIG. 5.—Case XII. Falling of humerus and consequent hollow between the acromion and head of the humerus shown in the left shoulder. *C*, clavicle; *A*, acromion; *S*, abnormal space between humerus and acromion; *H*, head of humerus.

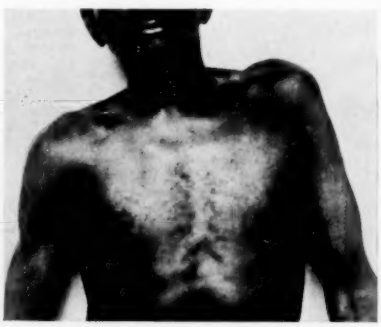

FIG. 6.—Case XII. Before operation. Degree of active abduction possible. This slight degree appears to be due to fixation of the shoulder-joint and turning of scapula by muscles of neck and trunk, and not to any action of the deltoid. Note that the hollow between the acromion and humeral head has disappeared. This usually happens on any movement or attempted movement of the arm. Cannot flex elbow in slightest degree.

FIG. 7.—Case XII. A very good position in which to dress the arm after operation. It should never be dressed at the side. Tightening of the axillary portion of capsule from abduction forces upward head of humerus, while the portion operated is relaxed and shortened by cicatrization.

FIG. 8.—Case XII. Shows abdominal space between acromion and humeral head. X-rays directed anteroposteriorly not in plane of acromion as in Fig. 4. Fracture of greater tuberosity found at operation not found in this X-ray. Long tendon of biceps detached from upper glenoid margin in this case, but falling of humerus no greater than usual on that account.

FIG. 9.—Case XII. Taken May 20, 1917, about a half minute after releasing his grasp of a tree limb by means of which he forced the arm into its full limit of abduction. He could keep it there against the pull of the contracted axillary tissues about a full minute. *A*, posterior operation scar, undergoing keloidal change.

evening, but came home early on account of pain. Swelling appeared on the following day and the pain and tenderness became so severe that she could not tolerate any handling of the part. The arm hung at the side helpless, except for the ability to make slight abduction. She went to bed on the day following the accident and remained there three weeks, but could not lie down on account of the pain. Twenty days after the accident she was etherized and a persistent effort was made by her physician to reduce what seemed to be a dislocation, but without success. I saw the patient for the first time at the University Hospital, on the thirty-fourth day after the accident, when she was compelled to sit up in bed most of the time and was unable to move the arm, except for a few degrees, in any direction. The head of the humerus was distinctly below its normal level with an abnormal depression between it and the acromion. Pressure upward caused severe pain at the shoulder. Measurement from the acromion to the external condyle showed lengthening of five-eighths of an inch on the affected side, and the X-ray showed a decided downward displacement of the humeral head, but no fracture of the greater tuberosity. Operation January 6, 1910. Incision through posterior fibres and not along posterior margin of deltoid as in preceding case, and capsule alone shortened. The most prominent symptom in this case was the pain, which was explained by the marked tension of the capsule before it was opened, and the escape of much dark grumous blood as soon as it was opened. Eight months after operation the patient reported that the arm was perfect except that she still could not hook up her skirt in the back. This difficulty disappeared later and she has engaged much in tennis and other athletic games, without the slightest trouble ever since.

CASE III.—Corpulent man, sixty-five years of age, subject to severe cardiac weakness and, therefore, not suitable for operation. On October 28, 1909, while attempting to catch a street car, he tripped and fell against the curb, striking on his right shoulder. When he got up the arm seemed helpless and felt as though it was asleep. He went home and lay on a sofa, soon falling asleep. When he awoke both arms were raised above his head, causing him to think there could not be much wrong with his injured shoulder. On the following day it was stiff and painful and he went to a hospital, where the shoulder was said to be dislocated and reduction accomplished, the arm being bound to the side and the wrist supported by a sling. He was an orderly at the Philadelphia Hospital, and on his return there the dressing was reapplied and the limb maintained in this position for a month. He says that for a long time after this the arm hung helpless at his side. He could flex the forearm slightly but required the aid of the other hand to complete the movement. The hand movements were always best and he could always write with it, provided the forearm were first brought to a resting position. He had had electrical treatments at different times but thinks they never did him any good. Examination, August 30, 1910, shows that he has good movement and power in the hand. The forearm can be flexed much better now than

some months ago, but not nearly as well as on the normal side. The arm by a strong effort could be abducted about 20 or 30 degrees, but with a considerable elevation of the shoulder (as in Fig. 6), and it was held there with some effort and pain at the shoulder. There is marked atrophy of the deltoid and posterior scapular muscles. Passive abduction is nearly normal. There is a distinct hollow between the acromion and head of the humerus, into which the fingers can be inserted. By pressure upward under the elbow, the humerus can be pushed up to its normal level and the patient can produce the same effect by muscular effort, but as soon as he relaxes, the humerus drops again. Measurements on both sides show a half-inch lengthening on the affected side. There is crepitation in the joint on movement but the X-ray is not clear as to the existence of a fracture of the greater tuberosity. Electrical examination by Dr. J. W. McConnell: On the right or affected side, the trapezius, biceps, extensors and flexors of the hand, the supinator longus and pronator teres, react normally to faradic stimulation. A current sufficiently strong to provoke contraction in the muscles by diffusion of the current, fails to cause any contraction of the deltoid. The muscles of the left shoulder and arm respond normally to faradic stimulation. This patient died of heart disease June 10, 1911.

NEW CASES

CASE IV.—Woman, single, fifty-eight years old, house servant. Admitted to the Philadelphia General Hospital, May 27, 1911, in the nervous wards, on the service of Dr. J. Hendrie Lloyd. Her chief complaint was of loss of power with tingling sensations in the whole left upper extremity. The patient was perfectly well when, several days before admission, she fell from a chair, on which she was standing, and struck on her left elbow, arm and shoulder. The tingling sensation is most marked in the fingers. She says that immediately after the fall the left arm lay under her body and that she could not move it except by grasping it with the right hand and pulling on it. She says "it felt as if it were dead" at that time.

Summary of examination by Dr. Lloyd: Gait and station good. Eyes negative. Pupils and cranial nerves good. Tongue protrudes in median line. Has slight tremor. *Right upper extremity* showed grip, power and motion unimpaired. Slight tremor in hand. *Left upper extremity* showed complete loss of power and motion and absolute flaccidity. Reflexes in biceps, triceps and pectoralis major absent. Tingling sensations in left arm, forearm and hand. Sense of touch and pain diminished, but not entirely lost in any part of the limb.

Dr. Lloyd asked me to see the case and to operate on it if in my judgment it was advisable. I found a distinct relaxation of the shoulder joint and the sensation unexpectedly good throughout the whole limb, and in view of the remarkable results obtained in the two preceding cases from simply restoring the normal shoulder joint relations and forced movements afterwards, I concluded to do the same operation in this case. I had not dealt with a complete paralysis

before. There was in addition in this case marked pain on movement of all the joints and a certain degree of cyanosis of the affected hand as it hung at the side.

Operation done July 1, 1911. Incision about five inches long along posterior margin of the deltoid, which was freed from the underlying external rotator muscles and retracted strongly upward, while the humerus was rotated strongly outward. The infraspinatus muscle, the first below the spine of the scapula, was separated from the shoulder joint capsule underneath, and the supraspinatus as far upward as possible. The capsule was then divided parallel with the glenoid margin and about midway between the glenoid and humeral attachments of the capsule. No signs of fracture or other injury discovered in the joint, except that capsule was abnormally long above. The circumflex nerve was exposed in the lower part of the wound, including a few of its branches. It was pinched with a tissue forceps several times without any response in the deltoid. With the arm held in abduction to about a right angle and external rotation, the capsule wound edges were overlapped by several catgut mattress sutures. Silkworm gut for skin sutures. Small rubber dam drain in upper angle of wound for uncontrollable oozing (most dependent position with patient lying on her back). Right-angled splint applied to inner side of arm and side of body, firmly, by adhesive plaster and bandages with arm in full external rotation. Primary healing. Drain removed in 48 hours. All support of arm and shoulder removed July 19, and arm gradually brought to side in a few days, after which it was supported by an adhesive strip under the elbow and over the acromion, with a sling for the forearm from the neck.

The return of power was very slow in this case and was associated with a very troublesome painful stiffness in all the joints. July 19, with the forearm resting on the patient's knee, there was very slight power to pronate and supinate the forearm. July 23, index finger could be moved slighly. Very slight dorsal flexion at the wrist. Pronation slightly improved. Can abduct elbow about four inches from the side. Some stiffness observed in all joints of the limb for the first time. (It may have been, and probably was, there before operation.) September 1, abducts arm about 25 degrees. Elbow cannot be passively extended more than about 140 degrees and in this position the arm hangs at the side. From this position she can flex the elbow to slightly more than a right angle. Can pronate and supinate forearm through a range of 10 to 15 degrees, and this with some force, supination being stronger than pronation. Has considerable flexion at wrist but less extension. Can touch side of index finger with thumb and can approximate thumb to within a half inch of litle finger. Has considerable movement of all fingers but cannot begin to make a fist.

Left hospital September 9, 1911, because she would not tolerate the pain induced by attempts at massage and passive motion to improve the very crippling stiffness and pain in all the joints of the limb.

By May 21, 1912, she had made remarkable improvement. She could actively abduct the arm at the shoulder to somewhat beyond a

right angle with the body and with the aid of the other hand could force it almost into full abduction. She had almost full flexion and extension at the elbow, and almost full pronation and supination of the forearm. The wrist movements had improved much, but she still lacked any considerable movement in the finger joints, and had most in the metacarpophalangeal joints. She was very anxious to go back to her work as a house servant, but the condition of her fingers would not permit her to do so. She was found dead in bed July 1, 1912. There was some reason to suspect suicide.

This is one of the most interesting cases I have had. The complete paralysis from the moment of the fall and the feeling as if it were then "dead," suggested very strongly the presence of a severe rupture of the brachial plexus. The preservation of sensation throughout the limb and the later complete disappearance of the paralysis, prove that a plexus rupture had not occurred. This patient was shown before the Clinical Congress of Surgeons, at the University Hospital in 1911, and at that time there was no suggestion of a brachial paralysis, only the evidence of a multiple joint condition.

CASE V.—Sailor, admitted to service of Dr. H. Siter at University Hospital, March 2, 1911. He had sustained on board ship a fracture of the neck of the left femur and a dislocation of the right shoulder which had been reduced soon after its occurrence. The shoulder became very stiff and painful and the arm very weak and helpless. Dr. Siter asked me to take charge of the affected shoulder and arm. On June 8, 1911, under ether, the arm was forced into nearly full abduction and external rotation and held in this position for three weeks. The cast was then removed and the arm allowed to come down to the side of the body gradually, after which exercises were employed to restore normal motion to the shoulder joint. For a time he seemed to be making satisfactory improvement and was discharged to return to the hospital for the exercises. A short time later he reported that the arm was not improving but losing in power. He was readmitted to the hospital August 3, 1911, when the following notes were taken: There is still considerable atrophy of the whole right upper extremity, the shoulder region and hand being most affected. Can abduct the arm at the shoulder about 30 degrees. Can flex and extend elbow and rotate forearm. Can close fist only to about a quarter of the normal, and must have the wrist in dorsal flexion to do this. There is a considerable depression between the acromion and head of the humerus (see Fig. 3), which can be made to disappear by pressure upward at the elbow. Measurement from the edge of the acromion to the external condyle shows on the left side 12¼ in. and on the right side 13 in. There is much atrophy of the hand and considerable atrophy of the rest of the limb.

Before my manipulations under ether he had the common type of traumatic brachial palsy without flail shoulder. He afterwards developed, evidently as a result of my manipulations, a typical case with flail shoulder. On August 5, 1911, I did the operation described in connection with Case IV. Primary healing. Right-angled splint re-

moved August 20, and arm allowed to work gradually to side in the following few days. Arm supported by adhesive strip under elbow and over acromion, and arm bound to side from August 26, when he was allowed out of bed, until September 1, when he was discharged from the hospital. At that time he showed considerable improvement in power of the limb since the operation and could close the fist of the affected side almost completely. I found it unusually difficult to keep in touch with this case afterwards. He refused to keep up treatment at the orthopædic gymnasium, for the stiffness of the shoulder which always results from the operation. He had a prospective suit for damages against the ship company on his hands and there was some reason to suspect that his arm was recovering too rapidly without special treatment. I was concerned now only about the stiffness of the shoulder and repeatedly urged him to force the shoulder movements before it was too late. His reply was: "The arm is coming around all right, now." After the successful termination of his suit for damages, he left the city for his home in Germany, where he has since remained.

CASE VI.—Man, seventy years old, huckster. While helping to "break in" a pair of horses May 14, 1913, he was thrown violently against the pole of a wagon, striking against the left arm. He was admitted to the Philadelphia Hospital, the same day, on the service of Dr. A. C. Wood, with whose permission I operated on and am reporting the case. There was a laceration of the right eyebrow and one on the left side of the nose. On the following day the whole left upper extremity was swollen, the shoulder region excessively, and there was much pain in all the joints. A dislocation of the shoulder was reduced by Dr. Wood. The X-ray showed a fracture of the external condyle and a possible fracture of the head of the radius. Flexion of the elbow was distressing because of the swelling and pain and the arm was bound to the side with the elbow in extension on an anterior splint. The swelling of the hand which was not included in the bandages continued to be severe. The bandages and splint were not removed until May 23, when the whole limb was observed to be almost completely paralyzed. On June 11 it was noted "that paralysis continues but there is slight movement in his fingers and slight rotation of the forearm. The humeral head drops slightly below its normal level, which is shown by the X-ray, and the shoulder joint is somewhat lax."

Neurological examination by Dr. Charles Potts, June 17: Arm can be abducted by force to angle of about 20 degrees. Forearm can be supinated only to midway between full supination and pronation, from the fully pronated position in which it usually lies. Voluntarily the arm cannot be elevated at all in any direction. Can rotate arm at shoulder slightly. No winging of scapula is present. Unable to flex forearm on arm, and attempt to do so with force, passively, results in flexion scarcely to a right angle. Can extend pronated hand to little above line of forearm. Can extend first phalanges on hand but not second and third. Can flex hand on wrist, but no power of deviation to either radial or ulnar side. Can flex first phalanges but not second and third. Some power of abduction of fingers but not of adduction. End of thumb cannot be approximated to any of fingers.

Unable to flex or extend end of thumb. No biceps jerk. Triceps jerk is slightly present. Wrist jerks are absent. Muscles of forearm and arm are atrophied. Hand is swollen and œdematous. Impossible to see whether intrinsic muscles of hand are atrophied. On little and ring fingers there is loss of pain sense. On dorsum of hand as far as wrist, on line with little and ring fingers, pain sense is diminished. Otherwise pain sense is everywhere intact. Electrical examination by Dr. Potts, June 23, 1913: Infra- and supraspinatus of left side respond slightly to a strong faradic current. Pectoral response O. K. Latissimus dorsi responds faintly. None of other muscles of arm respond at all to faradism. Absence of faradic contractility shows impairment in the nerve supply of these muscles. On the basis of these findings Dr. Potts's diagnosis was, *brachial nerve paralysis.*

The same operation as in Case IV was done on the left shoulder on June 24, 1913, and arm fixed at right angles with body on splint. Patient says two days later, June 26, "the left hand now seems alive," and that before operation it felt "numb and dead." There is already a slight but distinct improvement in the movements of the hand, but it is general and, therefore, not easily described. Swelling of hand distinctly less and impaired sensation over dorsum of hand also lessened. Patient says he has now normal sensations on the left as on the right side. July 14, for past few days had been allowing his arm to fall from the splint and to come to an angle of about forty-five degrees with the body. To-day it is fixed in this position with a suitable splint. Hand and forearm still show some swelling. Moves all fingers actively at the first joints much more freely than before operation, and slightly at the second joints, but not at all at the third.

The stiffness and pain in all the joints of the limb seen in Case IV were characteristic of this case also, and were also much worse in the hands than elsewhere. In Case IV, the paralysis was complete, while in this one it was almost complete. The recovery from the paralysis was likewise very slow in this case, and when this patient died, January 9, 1915, it had completely disappeared, the limb at that time being in practically the same condition as the affected limb in Case IV at the time of her death. In neither of the two cases could death have been due to the operation on the affected limb.

Le Breton[1] calls attention to what appears to be the same condition affecting the hand after Colles's fracture. In his last paper[2] he includes among his case reports a reference to this patient whom he saw when I exhibited him before the members of the American Orthopædic Association, at the University Hospital, June 17, 1914. Two of my later cases were more mildly affected than this one and Case IV, and I have seen it several times in shoulder injuries without flail shoulder joint. Le Breton attributes the condition to a multiple arthritis of the hand in his cases, although he says there was a dense œdema and a low-grade cellulitis. I am confident that in my shoulder cases all the tissues from the shoulder to the ends of the

[1] Amer. Jour. Orthoped. Surg., November, 1911.

[2] Surg., Gynec. and Obst., 1915, xx, 450.

fingers were involved in the pathological process, as shown by a marked tenderness in all parts pressed on. Restricted motion in the joints was the most evident sign of the condition. It slowly becomes less acute and finally the pain and tenderness disappear, but leave a serious restriction of movement in all the joints of the part involved. I have not yet seen perfect movement recovered in any of the joints, although the larger joints have recovered much. But the hands, in both of my cases that died about a year after the accident, were at that time practically useless. I have no idea of the cause of the pathological process at the bottom of this condition, but I suspect that there is from the site of injury to the ends of the fingers a low grade of inflammation with exudate which affects the muscles and other soft tissues, but the synovial cavities most seriously. The numerous joints of the hand and the more extensive synovial lined tendon sheaths may become the seat of infiltration and adhesions which could account for the very troublesome involvement of the hand. Le Breton refers to some formation of adhesions in the tendon sheaths. There is room for question as to whether well developed adhesions between the tendons and their sheaths in the fingers will ever disappear and permit free movement of the tendons in their sheaths again.

Case VII.—Man, physician, referred September 12, 1913, by Dr. T. H. Weisenberg. Strong and healthy except for trouble in right upper extremity. In October, 1905, he was riding on a railway train, being seated near the window and the only passenger in the seat. His train was going westward and was being passed by an east-bound train. Both engines were taking up water at the time from troughs between the tracks underneath. The water thus disturbed was thrown through the window into the patient's face. This startled and confused him and during the excitement he was injured in some manner, becoming unconscious. He did not recover consciousness until 18 hours afterward when he was in the Altoona Hospital. His neck was stiff and he had slight swelling at the base of the skull in the occipital region. His chief trouble was in the right upper extremity. The whole limb was very painful but showed little swelling. Sensation was not tested and he does not know whether it was disturbed or not. The limb was paralyzed but not completely, and as far as he can recall about the same parts of the limb were involved as now. About five or six days after the accident a dislocation of the shoulder was recognized but he does not recall that any attempt was made to reduce it. The arm was bandaged in the Velpeau position for six or seven weeks. He then came to Philadelphia and a surgeon took the arm from this position and said that there was no dislocation. The probability is that the subluxation or relaxed joint was present from the time of the accident. An X-ray showed a cervical rib on this side which was removed.

My findings were as follows: The general picture presented by the brachial paralysis was very similar to that seen in Cases I, II, III, and V, which seem to be far the most common type. His greatest

power was shown in the hand and wrist and these seemed to be about normal, indicating that the muscles which move the hand, most of which come from and make up most of the forearm, were practically normal. Pronation and supination of the forearm could be made but their power was considerably below the normal. The action of the biceps is very weak, but that of the triceps is very good, almost normal. All the muscles in the shoulder region are very much atrophied and the upper end of the humerus is almost subcutaneous. Sensation is good throughout the whole limb, except about the shoulder, where it is much disturbed but not lost. The shoulder joint is flail, the humeral head falling about a half inch below the acromion. The doctor was so anxious to return to his home that he could not give the time for an electrical examination. I did not advise in this case the operation done on the others, because of the eight years which had passed since the causal injury. In the absence of an electrical examination, and in the presence of the profound atrophy and impaired sensation of the shoulder region, I think that the affected muscles must have undergone degeneration beyond ability to recover as in the preceding cases operated on. Probably, only an arthrodesis or the transplantation of a portion of the trapezius into the deltoid could improve conditions in this case.

Although the limb was swung flail at the shoulder and was very much crippled, it was far from being a useless one. The grip of the hand was about as good as on the normal side. In a severe forceps delivery, after placing the right forearm in a suitable position, he found the hand very serviceable. The profound paralysis is distinctly localized to the muscles surrounding the shoulder joint, and grows progressively less the further we go down the limb away from the shoulder, until we find practically if not the normal power at the wrist and hand. I think it doubtful that any injury of the brachial plexus could produce such a severe paralysis and atrophy in the shoulder region without affecting any of the numerous muscles which move the wrist and hand, and which include almost all the whole mass of muscles of the forearm.

Case VIII.—In this case the shoulder condition and brachial paralysis were overshadowed by the fracture of the humerus, pain, general distress and breaking down, which continued until the fatal termination and for which I have no explanation. No opportunity was afforded afterward to observe the effect of the operation on the movement of the shoulder joint and power of the limb, so that the report of the case might be omitted so far as its influence on the subject under discussion is concerned. It suggests why the shoulder joint condition is sometimes overlooked at the time of the accident.

Woman, forty-six years old, looks as if she might be 60 years old. Weight a short time before the accident 140 lbs., now 99 lbs. My first examination December 8, 1913. Referred by Dr. B. A. McDermott. August 30, 1913, tripped and fell to the floor in her home and injured the right arm. Two days later went to a hospital where a double fracture of this arm was diagnosed, and arm bandaged in Velpeau position. After three weeks plaster cast applied with arm in same position. At the end of seven weeks the cast was removed and non-

union discovered. She complained of much pain and this was accounted for by the statement that a nerve had been caught between the fragments. She was then etherized and the arm "broke over again" and a Velpeau bandage applied. For the past two weeks the arm has been at her side in right angle flexion, being supported by a sling from the neck under the forearm from the elbow to the wrist. She still complains of much pain in the arm.

On examination I found an ununited fracture about the middle of the humerus. The head of the humerus was much below its normal level under the acromion and could be pushed upward somewhat by pressure under the elbow, but not to its normal level on account of the pain produced at the fracture and shoulder joint. The joint is not flail as usual in this condition, but the head is more movable than normal from direct pressure on it. There seems to be considerable inflammatory infiltration in and around the joint. Sensation is present throughout the whole limb, but is best in the hand. Can move the hand weakly, pronate and supinate the forearm weakly and has slight power of flexion and extension at the elbow. Has not enough power, however, to lift her hand from her lap. Arm movements cannot be made on account of pain but she seems to have a little power in it. Patient looks weak, pale and distressed. Complains of almost constant pain in the affected arm.

Operation December 18, 1913, at University Hospital. Incision along posterior margin of deltoid which was retracted upward and outward and the arm was rotated backward. Tendon of the infraspinatus divided and dissected backward from the capsule, which was divided parallel with and midway between the glenoid and humeral attachments. Abduction of the arm was difficult because of the axillary inflammation but this forced the humeral head to its normal level under the acromion. The edges of the capsule wound were overlapped by catgut mattress sutures. In passing the needle for one of these sutures, it was observed that the needle passed with some difficulty and was seen emerging from the cartilaginous covered portion of the humeral head. It had passed through the bone for the distance of about an inch and about a half inch below the cartilage. This indicated a profound disturbance of nutrition.

The wound was then extended downward on the outer side of the arm almost to the elbow, passing over the circumflex nerve above and below the musculospiral below. The latter was lifted from its bed and retracted backward as much as possible. The middle of the humeral shaft for about three inches was broken up into small fragments, and the bone appeared to be soft when handled with forceps. Because of the weak condition of the patient, the desire to avoid hemorrhage as much as possible, and the hope that they might aid in making union more rigid, these numerous small fragments were not removed. The rough edges of the two main fragments were sawed off and brought together, the small fragments being pushed aside. A long Lane plate reaching from the surgical neck to the external condyle was applied and fixed by screws. Capsule sutures then tied, infraspinatus sutured,

muscles brought together and skin wound closed without drainage. An attempt was made to dress the arm at right angles with the body, but the screws had a poor hold on the soft bone and it was, therefore, brought to the side and fixed in this position with a light plaster cast, the forearm being placed across the chest and pressure being made under the elbow to keep the humeral head as far up as possible. Primary healing took place except for a very small opening at the lower angle of the wound which drained a serous discharge. An X-ray taken five days after operation showed that the screws had given way and the fragments separated. A week later the screws were removed. During the next four weeks the cast was renewed three times in the effort to relieve her distressing pain but without success. Discharged January 25, 1914.

May 13, 1914. In office to-day. Complains of much pain in right arm and back. Since leaving the hospital has developed a persistent cough, expectorates a purulent sputum and sweats profusely at night. Died July 16, 1914.

Case IX.—Man, colored, 53 years old, laborer. Admitted to Philadelphia Hospital August 3, 1914. About the latter part of the preceding June, he was compelled to give up his work on account of the pain in the left shoulder and helplessness of the left arm. He does not recall any severe injury to the shoulder or arm, although he thought his trouble began with and was due to a heavy strain of this arm and shoulder from shovelling stones while engaged in " concrete " work. He seems to recall the particular time at which it occurred, and referred to a particular shovelful and the way he threw it over his head. His statements, however, appear to be unreliable. He says that soon after this incident, or about the third of July, he sought relief at a hospital dispensary, where his condition was diagnosed as rheumatism, for which he was given medicine. He continued treatment there for about a month and on finding that he was not getting better and was unable to work, he came to the Philadelphia Hospital. On examination I found slight atrophy of the whole limb, most marked in the arm. The shoulder was tender on pressure and the pain was much aggravated on passive movement which was about fifteen degrees and passive abduction was not much better. The movements of the hand, wrist and elbow are not mechanically restricted, but it is difficult to determine how much power he has. Except for some weakness, the hand and wrist are normal, but the limb as a whole is almost useless. He says that it has improved a good deal since the beginning of the trouble. The head of the humerus has fallen about three-quarters of an inch below the acromion as shown by the X-ray and palpation. Efforts to push the head up to its normal level are only slightly successful and cause much pain. Because of the resemblance of these symptoms to those which preceded operation in Case II, it was suspected that the joint would be found filled by a similar material.

Operation August 13, 1914. Because the patient objected to taking ether, he was given hyoscine gr. 1/50 and morphine gr. 1/2, divided into three doses. An attempt was also made to anæsthetize the brachial

plexus by the Kulenkampf method, and the skin in the line of the incision was injected with the same novocaine solution (2 per cent.). He was then turned on his right side and an incision made in the line of the deltoid fibres from the posterior edge of the acromion about four inches downward, care being observed to avoid the circumflex nerve. After going through the deltoid the infraspinatus was exposed and divided in the line of its fibres, *i.e.*, almost at right angles with those of the deltoid. This exposed the posterior part of the capsule, but only a small part of it with the widest possible separation of the infraspinatus wound. By strong traction on the margins of the wound, however, and rotating the humerus, first in one direction and then the other, the capsule could be freed a considerable distance above and below with the aid of the finger and a blunt pair of scissors closed. There was much less hemorrhage than usual. The joint was opened by the usual capsule incision, parallel with the glenoid and humeral attachments, which was extended upward and downward with the scissors aided by the guidance of the finger where the capsule could not be seen. Particular care is necessary to avoid cutting the circumflex nerve in the lower part of the wound and the long tendon of the biceps above which can be felt free in the upper anterior part of the joint. Before the joint was opened the capsule was observed to be under tension and as soon as the capsule was divided, a considerable quantity of a grumous, jelly-like substance escaped. Much of it had to be removed by the fingers. The small visible portion of the cartilage of the humerus was normal to sight and this as well as all the cartilage of the humerus and glenoid that could be felt had a normal feel, indicating that the jelly-like substance was not the result of an infection. It has always been difficult to introduce the capsule sutures and it was especially so in this case so that they were not used. The arm was abducted to just beyond a right angle, which forced the head up to its normal level by tension on the axillary portion of capsule. No sutures were necessary in the infraspinatus wound. Catgut for the deltoid incision. Silkworm gut for the skin. Small rubber drainage tube to the capsule. Dressing. Right angle splint and light plaster cast fixed arm in this position and nearly full abduction. Drainage tube removed in 48 hours hours, skin sutures in ten days and cast and splint in four weeks. Whole limb completely paralyzed, then, except for slight movements in fingers. September 29, 1914, gradual improvement in movement and power of hand and forearm. Shoulder still stiff and painful.

Persistent efforts were made to induce this patient to use forceful exercises to overcome the stiffness from the original injury and the operation, but he would have none of it. Once he paid a visit to the surgical dispensary of the University Hospital where he could have the services of a masseuse, but he complained of the pain and would go no more. I did not see him again until February 13, 1916, when he appeared to have full power and development of all the muscles of the affected limb, although he could abduct the arm only to the level of the shoulder and had corresponding limitation of external rotation. He was earning his living as a laborer.

Case X.—Man, printer, 42 years old. Admitted to the Philadelphia

Hospital July 17, 1914, on the service of Dr. H. R. Loux, with a fracture of the lower end of the radius, comminuted fracture of the surgical neck and upper third of the humerus and subluxation of the shoulder joint on the left side. About one week before he had fallen down a flight of stairs, injuring his left forearm, arm and shoulder. When union had been obtained in the fractured humerus and radius, Dr. Loux kindly turned the case over to me for treatment of the shoulder condition. The whole limb was then very weak but had most power in the hand and wrist as usual, the power at the shoulder being practically nil. As my service ended October 1 at the Philadelphia Hospital, I had the patient transferred to the University Hospital and operated on the shoulder October 15, 1914. Incision along posterior margin of the deltoid. Fibres of the infraspinatus separated as in last case, exposing the capsule. Edges of the wound retracted as far as possible, and by rotating the humerus as far as possible, first in one direction and then in the other, the capsule was freed from the overlying muscle well upward and downward. Capsule divided as in preceding cases, and, as more room was available than in the last case, three mattress catgut sutures were employed to overlap the capsule margins, while the arm was held in abduction to about a right angle and external rotation. No abnormality was detected in the joint in this case. Very small drainage tube to the infraspinatus. Catgut suture of the skin wound. Dressing. Light plaster cast with arm at right angle abduction and nearly full external rotation. Drainage tube left in five days. Primary healing. Cast removed November 5, 1914, the patient remaining in bed to allow the arm to come to the side gradually, which it did in four days. As usual, the humeral head was now held firmly up under the acromion but the shoulder region was painful and tender because of the tension on the shortened structures. Massage daily. Left the hospital November 13. February 8, 1915, in my office. Abducts arm easily and quickly to angle of 160 degrees and has almost normal external rotation. There still remains slight mechanical restriction of shoulder movement which he promises to work out by more vigorous exercises. The power of the whole limb is practically normal.

Case XI.—Married woman, Italian, 21 years old, admitted to the Philadelphia Hospital August 21, 1915. About a month before admission, she woke one morning to find that she was not able to lift her left arm from her side. She says that she could move her fingers but they were very weak. She could not move her forearm except by picking it up with the other hand. The day before she had been working hard cleaning her two rooms, and this included the moving of her furniture, the heaviest of which was a brass bed. When she went to bed the night before she had not noticed any trouble with the left arm. On the following morning when the arm was paralyzed, the shoulder and arm were very painful and the muscles very tender. She has not noticed any ecchymosis at any time. About two days after the beginning of the trouble, she went to a doctor who told her the condition was due to a cold. A man, who has been a hospital attendant at the Philadelphia Hospital for, at least, thirteen years, and is unusu-

ally reliable, saw her within a week after the beginning of the trouble and he says that her shoulder and arm at that time were " swollen and red." The redness suggested inflammation to him but evidently was not of the infectious variety. At the time of admission, the power of the hand and forearm was good but below normal. She could abduct the arm from the side only about 20 degrees, while passive abduction was almost but not quite normal and caused considerable pain. She left the hospital September 3, 1915. About a week before Dr. J. W. McConnell made an electrical examination with the following results.

Galvanic current; Right deltoid, with the cathode, shows normal response, good volume, to 35 cells.

On left side, same position, gives no response. Biceps on right side, normal. On left shows good prompt response but not quite as good as on right. Triceps on right normal, on left not obtained. Supraspinatus on right normal. On left normal. Over left deltoid there is no response to anode or cathode, using a current strength which gives a very positive reaction on the right side. Same is true of the triceps on the left side. An area of hypalgesia on the left side, commencing about an inch above the tip of the acromion process, about an inch and a half broad tapering extending down over the shoulder 2½ to 3 inches. Otherwise the sensation of the arm is normal.

The power of the arm at the shoulder showed marked improvement every day until when she was leaving the hospital she could raise it straight up alongside her head. She could raise an ordinary kitchen chair with the right or normal arm, but could not raise it from the floor with the left arm.

Two days after the patient left the hospital, Dr. McConnell made the following examination at his office:

Faradic current: Right side; Deltoid, ant. mot. point, normal response. Post. mot. point, normal response. Pect. maj., mot. point, normal response. Trapez., mot. point, normal response. Infrsp., mot. point, normal response.

Left side: Same current and strength; Deltoid, ant. mot. point, much less than normal response. Post. mot. point, slightly less than normal response. Prot. maj., mot. point, much less than normal response. Trapez., mot. point, normal response. Infrasp., mot. point, much less than normal response. In all these tests the current strength was equivalent to four sections of a Fleming coil, the iron core being entirely covered.

Galvanic current: Dry cell battery, forty-five cells.

Right side: Normal response at all motor points previously examined by faradic current.

Left side: Deltoid, post. mot. point, normal response, *i.e.*, identical with response obtained on right side. Ant. mot. point, with cathode as active pole, application is not followed by immediate response. Quite some time is required to overcome the resistance. The response at first small, increases in volume until a very violent muscular action is obtained. This action, however, is not limited to the muscle under examination, but is diffused to other muscles constituting the shoulder

group; with the anode, some time is required to overcome resistance and the response is fairly large, but is confined to the portion of muscle under the electrode and there is not the same sharp contraction which is obtained on the normal side. The same is true as to the other points examined which were found by the faradic current to differ from the normal side. Dr. McConnell's conclusions: This patient has had a neuritis from which she is recovering. The peculiar response which is obtained is due to the subsidence of the neuritis and the restoration of electrical conductivity. That this has not been fully restored is evidenced by the qualitative change to galvanism, serial and modal.

Patient examined at Philadelphia Hospital March 4, 1916. Left arm has recovered much of its normal power, so that it can be used very well in doing her housework. There is, however, a small distinct difference in power of the two limbs. This difference is more distinctly manifested by the rapidity with which the left arm tires and that shoulder begins to ache, when the arm is used. The patient finds herself unconsciously using the right arm to save exhaustion and pain. When lifting a weight with the left hand she is conscious of a peculiar giving way or dropping of something in the shoulder of that side.

Patient seen again at Philadelphia Hospital May 5, 1917. The mild relaxation of the left shoulder joint still persists (see Fig. 4) although the power of the shoulder muscles has improved slightly but distinctly since the last examination. The patient uses this arm in all her work without special difficulty, except that it tires easily, is weaker than the right and after being used for a time begins to ache. An effort was made to determine the difference in strength of the two arms. The testing could not be applied directly to the shoulder muscles, but special apparatus in the gymnasium of the University of Pennsylvania was employed. The following results were obtained: Grip of both hands was the same. Pulling by grip of hand with arm held forward level with shoulder and counter-support against front of chest (flexors): Right side 45 kilograms and left 30 kilograms. Arms at same level and back supported, pushing object away by hands (extensors): Right 52 kilograms and left 50 kilograms. Lifting by hands in standing position: Right 145 kilograms, and left 125 kilograms. When hanging by the right hand she readily suspended her whole weight, but when using the left hand could not take her feet from the floor because of weakness in that arm and some pain at the shoulder. A number of dumb-bells were tied together by a piece of rope, a loop at the other end for the hand and long enough to reach above the level of her shoulder. The whole weight was 36 pounds. On the first trial she lifted this weight from the floor with the right hand and held it for 12 seconds, and with the left hand for six seconds. After several other trials without timing, a second test showed that she held up this weight with the right hand 24 seconds, and with the left one second. In other words she barely lifted the weight from the floor for a moment with the left hand. She said the left shoulder felt exhausted and was aching and had the sensation of giving way when she tried to lift.

It will be recalled that the history does not show a traumatic origin in this case. I have assumed that it was traumatic as I believe the origin was traumatic in case IX, and as it evidently was, although very slight, in case II. One would hardly expect as severe a condition from the degree of trauma in cases I and III, yet there can be no doubt of a traumatic origin in these two. A mild original injury agrees with the mildly flail joint, slight dropping of the humeral head shown by the X-ray, and mild permanent impairment of function of the shoulder muscles, in this case. The skiagraphs in Fig. 4 indicate that the mildly flail shoulder joint is probably permanent and that the patient will never recover perfect function in it.

Case XII.—Colored man, 58 years old, laborer. Admitted from the neurological dispensary to the surgical service of Dr. C. H. Frazier in the University Hospital January 17, 1916. The following history was taken by the interne, Dr. W. Frank. Five weeks before, he was thrown from a wagon striking on his left arm, shoulder and head. He was unconscious for five or ten minutes. Since that time he has not been able to raise the left arm from his side nor flex his elbow. Otherwise he was perfectly well. He can move the arm only by swinging it from the shoulder. The acromion on this, the left side, is more prominent than on the right. Extension at the elbow is about normal in extent and power. The power of abduction is nil, but adduction is fairly good, almost as good as on the right side. Internal rotation is normal, but external rotation is slight. There is marked atrophy of the deltoid, supra- and infraspinatus and trapezius of that side. There is no weakness in the elevation of the left shoulder girdle. Lelt deltoid jerk is present but diminished as compared with the right. Left biceps jerk is present but very weak. Left triceps jerk is normal. No weakness of muscles of left forearm. Sensation is normal over the left shoulder region, chest, back and left arm. January 20th, the muscles and nerve reactions were tested to-day. No reactions of degeneration were found.

The following examinations were made in the neurological dispensary, January 3, 1916: "Complete paralysis of left deltoid, triceps, brachialis anticus, supraspinatus, infraspinatus. No disturbance of sensation. Triceps and muscles of forearm and hand good. No faradic response over following muscles in left arm: Biceps, deltoid, triceps (?), supinator longus. Slow response over extensors. Slower response of flexors of fingers on left as compared to the right." Second Examination, January 5, 1916: "No faradic response over supraspinatus and infraspinatus, biceps and deltoid. Good response over triceps, flexors and extensors, though slower than on right side." Third examination, January 20, 1916: Faradic response in deltoid and in biceps on left side obtained with current stronger than is used on right side, but the response is very prompt. Other muscles of arm and forearm respond in normal manner.

Operation January 25. Incision along posterior margin of deltoid. Infraspinatus muscles lifted from capsule which was further exposed upward and downward under the teres minor. Usual incision in capsule. Finger in joint failed to locate the long tendon of the biceps

which is usually found easily. Second incision along anterior margin of pectoralis major and capsule opened over the bicipital groove. The long tendon of the biceps which normally occupies this groove, could not be found as it had torn from its attachment to the upper glenoid margin and had retracted downward from view. The greater tuberosity was unduly prominent and the bicipital groove obscured from a previous fracture. No sutures in capsule wound. Continuous No. 1 iodine catgut suture for anterior and posterior skin wounds. Small rubber drainage tube in lower angle of posterior wound for uncontrollable oozing. Dressing and bandage. Arm fixed by light plaster cast at an angle of about 130 degrees and nearly full external rotation (see Fig. 7). January 27, hole cut in cast and drainage tube removed. February 6, primary healing and patient sent home with arm in cast. Returned to hospital February 20 and on following day cast removed. Patient remained in bed for next four days to allow arm to work down to side slowly. There was then moderate swelling from the shoulder to the fingers. The whole limb was much weaker than before the operation. The triceps which was normal before operation now shows little or no power.

The return of power was unusually slow in this case. I did not see him again until April 18, 1916, when he could use the hand very well but in the standing position could not flex the elbow in the slightest degree. He could abduct the arm from the side about 20 degrees. In the recumbent position he could abduct it about 60 degrees and lift the whole limb forward from the shoulder. With the arm elevated a little he could flex the elbow weakly and carry the hand to his mouth. There was still a marked limitation of movement at the shoulder. It is evident that he has failed, almost entirely, to force the movements of the shoulder because of the pain involved. June 8, 1916, there was a marked improvement in the power of all the muscles but in the upright position he still was unable to make any flexion at the elbow. In the recumbent position he could carry his hand to his mouth rapidly. August 6, 1916, there was a decided improvement in power throughout the whole limb, but there is little or no improvement in motion at the shoulder and a decided crepitation is developed on passive movements of it. In the standing position he can flex the elbow and carry his hand to his mouth and top of his head easily. He can support his whole weight by the grasp of the hand of the affected arm. Examination October 16, 1916, by Dr. W. B. Cadwaladar, in the neurological dispensary of the University Hospital: "To-day all the muscles of the left shoulder girdle contract well and with considerable power but not quite so strongly as the corresponding muscles of the right side. It seems as if the only disability was entirely due to arthritis or adhesions about the shoulder joint. There are no changes of sensation for light touch, pain or temperature, *i.e.* sensation is normal. All movements, flexion, rotation, supination, abduction and adduction, can be well performed, except for limitation in the joint. There is positively good contraction of the left deltoid, biceps, brachialis anticus, supra-

spinatus, triceps and infraspinatus. There is possibly less power in the infraspinatus proportionately than in the other muscles." While the return of power has been slow in this case, it has never ceased to progress and is as rapid now as at any time.

April 29, 1917, the patient reports that he has been at work as a laborer for a few months, working every day and doing a full day's work, earning fifteen dollars a week, an unusual amount for him. He seems to have full power in most of his muscles, but still can not elevate the arm above his head because of the limitation of movement in the shoulder. He was readmitted to the University Hospital February 26, 1917, for the removal of a keloid growth on the back of the right shoulder, and while under ether the left shoulder was manipulated as strongly as was felt to be safe in an effort to restore some of the restricted movement. This did not seem to be successful, but an opportunity was afforded while he was in the hospital to drill into him the kind of exercises that were necessary to restore motion. He is now able, after going through some preliminary exercises, to hold the arm up in the air for a short time by bending his shoulders backward (see Fig. 9). For six months after operation he probably made little or no effort to exercise the shoulder and until his last visit to the hospital showed marked indifference.

Case XIII.—Man, 52 years old, referred by Dr. J. Binder. About a week before Easter of 1916, while fixing an awning, he fell from a ladder from the level of the second story, injuring his left shoulder. It appears that there was a dislocation at the time which was reduced at a hospital on the following day. The arm was dressed in the Velpeau position and the patient discharged the same day to return to the dispensary daily. The bandages were removed in three weeks and massage and passive movements given for six weeks more. Immediately after the accident the whole limb became helpless and was very painful.

Examination June 20, 1916, about twelve weeks after the accident. Sensation is good throughout the whole limb. He can abduct the elbow from the side about four or five inches, and elevate it forward to about 45 degrees. Posterior elevation is nil. With his arm at his side he can flex the forearm to about an angle of about 45 degrees and can just touch the thumb to the mouth by bringing the mouth toward it as far as possible. In the recumbent position with his arm at his side and the hand touching the floor, he can flex the forearm at the elbow only very slightly, *i.e.*, he can lift the hand only about 3 inches from the floor. In this position he has practically no abduction. Rotation of the forearm is only slightly limited in range but is very weak. There is a considerable œdematous swelling of the hand and fingers which extends about halfway up to the forearm. He has passive abduction at the shoulder to about 45 degrees. There is a distinct dropping of the humeral head below the acromial process but by pressure under the elbow it can be forced up to its normal level only to drop again as soon as the pressure is removed.

The following neurological examination was made by Mr. Arnett, a fourth year medical student in the Neurological Dispensary of the Uni-

versity Hospital: Although left-handed the patient's left arm is smaller than the right (measured at biceps, L. 26 cm., R. 27.5 cm.). Left forearm 25 cm., right, 25.5 cm. There appears to be some dropping of the shoulder and the head of the humerus appears to be lower than the right. All movements can be performed with the left hand and forearm but they are very limited. The fingers can be moved only 30 degrees, the wrist 35 degrees, the forearm about 50 degrees. Heat, cold, touch and pain are normally perceived in the left hand, forearm and arm. The left hand, œdematous and shiny, measures 21 cm. across the knuckles, while the right measures 19.5 cm. The following electrical examination was made by Dr. J. W. McConnell: Right upper extremity shows no abnormality to either current, faradic or galvanic. In the left upper extremity there is no response to faradism in the deltoid muscle. All other muscles respond, but a slightly greater current strength is needed than is used on the right side. To galvanism all muscles respond normally save the deltoid which shows both serial and modal changes.

Operation was performed June 28, 1916, at the University Hospital. Same incision through deltoid and infraspinatus as in case IX, and same incision in capsule. With arm in full abduction and external rotation, the finger could be passed to the anterior part of the joint where the torn edge of the capsule could be felt and in it a fragment of bone torn from the anterior glenoid margin. This is the common ligamentous lesion of a dislocation. No sutures were introduced into the capsule. The deltoid incision was closed with No. 1 plain catgut. Same for skin. No drainage except between sutures. Plaster cast with arm in full abduction and external rotation. Primary healing. Cast removed in two weeks on account of distress it caused. Arm brought to right angle and fixed there by splint, which was removed a week later and the arm brought to the side. There was already a considerable improvement in the movement of the elbow and hand but the swelling which had largely disappeared with the arm elevated reappeared after it had been let down. On December 9, 1916, he could elevate the arm almost to the horizontal. The elbow movements were normal and the hand movements much stronger although still considerably limited in their movements. There is now very little swelling in the hands and fingers and above the wrist. Because of the pain at the shoulder the forearm sling was used until three weeks ago. April 25, 1917, all movements of the limb have improved very much. Can almost close fist as on normal side and uses the hand and arm in his work very well. There is a still slight swelling of hand and weakness of whole limb. Can elevate arm forward to about 110 degrees actively, and after lifting it up straight above his head with the other hand can hold it there by tilting his shoulders backward slightly. This is a recent accomplishment, but is an evidence of what has proven true of all the cases, *i.e.*, after the joint has been restored to its normal relations and firmness the improvement never seems to stop until the normal is reached or closely approached. Restriction of movement is the only obstacle to a return of normal function.

CASE XIV.—Man, 65 years old. Particularly dull and slow mentally and physically. Admitted to the Philadelphia General Hospital, November 29, 1916, to the service of Dr. H. R. Loux, who kindly turned the case over to my service. Ten days before admission he fell on a slippery pavement and sustained an injury to the left shoulder, was taken to a station house and did not believe until the following day that his left arm was hanging helpless at his side. He says that he went to a hospital the same day and had a dislocation of this shoulder reduced. On admission his hand was practically useless: he could not abduct the arm from the side and had only very slight power of flexion at the elbow. He had a little movement in the fingers. Passive movement at all the joints is painful and probably accounts for some of the failure to move the different parts of the limb. This applies particularly to the wrist drop which is present, as passive extension beyond the straight position in this joint is very slight because of the stiffness and pain. There is a distinct hollow to palpation under the acromion and consequent flail joint. This could not be shown by the X-ray because on repeated trials he would, when the machine was started, obliterate the interval between the acromion and upper end of the humerus by unconsciously contracting his shoulder muscles. There are areas of disturbed sensation especially in the hand. There is a tinge of cyanosis and slight swelling in the hand and the fingers can not be fully flexed, while efforts to force them cause pain.

Electrical examination by Dr. S. Leopold at the University Hospital:

No response to the galvanic current in the biceps or other muscles of the left arm, but with strong faradic current reactions were elicited in the biceps, long head of triceps and in the deltoid. These reactions were weak in all three muscles. In the other muscles about the shoulder (supraspinatus, infraspinatus, pectoralis major) no response was obtained. Considerable pain was complained of when the current was applied to the left shoulder region, while with the same current on the normal side there was no pain, showing, therefore, a very hyperæsthetic area about the injured shoulder. No reactions were elicited in the extensors of the forearm.

This case seemed to offer the opportunity of trying out an idea which had suggested itself some time ago. If, as I believe, these flail shoulder cases are ordinary anterior dislocations in which the hyperabduction has been extreme enough to tear the capsule from the humeral attachment all around, with consequent dropping of the humerus until other surrounding structures take up the support, it would hardly be good surgery to fix the arm in abduction at the time of the accident. This would force the humeral head into the dislocated position and keep it there. But three weeks had elapsed in this case, so that sufficient healing had occurred in the axilla to prevent dislocation when the arm was forced into full abduction. Enough tearing of the cicatricial axillary tissue would probably occur to cause considerable joint inflammation and shortening of the upper part of the capsule if it were kept relaxed by abduction and external rotation long enough. On

December 12, 1916, under ether, the arm was forced into full abduction and external rotation with evident tearing of tissues in the axilla, and kept in this position by a plaster cast. This was removed January 30, 1917, six weeks later and patient kept in bed about a week later while the arm was gradually coming down to the side of the body. He was let out of bed a few days later with the forearm in a sling which was soon discarded. He was encouraged to force the arm back into the fully abducted and externally rotated position as often as possible. He did this fairly well and had almost all of these movements passively when he was sent to the City Home for the Indigent, February 15, 1917, but he had gained only slightly in power. He was readmitted to the hospital with croupous pneumonia March 15, 1917, and died of this condition five days later. The shoulder joint was still firm and not in the least flail when he was discharged from the hospital and probably did not become relaxed later.

*Conclusion.*—The effort here has been to show not how the flail shoulder produces the permanent paralysis so much as to show that it does. The only worth-while proof offered is that early removal of the flail joint and restoration of normal motion in it, results in the disappearance of the paralysis. It hardly seems necessary to argue that if the paralysis and flail shoulder had been caused by a rupture of the brachial plexus, recovery would not have followed, uniformly, treatment restricted to the shoulder joint. According to my experience, in most cases of traumatic brachial paralysis the shoulder joint is not in the least flail, but on the contrary exhibits limited movement and pain when movement is made. Is it not fair to ask those who account for these cases by an injury of the brachial plexus, to explain why the flail shoulder is found in only a few? The following observation made during the past six years seems worthy of some attention. I have read almost every paper on obstetrical paralysis published within recent years and many old ones, and have constantly been on the lookout for the report of an obstetrical palsy with flail shoulder but as yet without success. I found twice a vague reference to the condition but without any reference to a case. In view of the large number of cases of obstetrical palsy reported, hundreds of them in recent years, I am inclined to doubt its occurrence. If it does not occur it then becomes necessary for those who account for the obstetrical paralyses by an injury of the brachial plexus to explain the absence of flail shoulder in this class of cases.

# MYXOFIBROMATA OF THE ABDOMINAL WALL

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Myxofibromata of the abdominal wall are not uncommon. They occur most frequently in women, especially during the childbearing age. The etiological factor in women is in the largest per cent. of cases due to rupture of the posterior sheath of the rectus muscle during labor. Other traumas may produce the same condition, especially in men. These tumors usually are the size of a hazel-nut or walnut. Occasionally they grow to an enormous size and have been reported as large as a child's head. They are firm, hard, generally round or spherical tumors and seem to follow the muscle fibres and tendon sheath of the muscle affected. The recti muscles are the ones usually affected. It is very rare that the oblique muscles are involved. The right rectus is most frequently the site for such a growth. They usually grow outward but occasionally inward. They are usually single in number.

The diagnosis is generally easy, especially where the tumor mass is small. A differential diagnosis will have to be made from lipoma, hæmatoma or abscess. Where the tumor attains a large size, especially where the growth is inward into the abdominal cavity, the diagnosis may be difficult. These larger tumors will have to be differentiated from intra-abdominal conditions such as ovarian cyst, nephroma, enlarged spleen, floating kidney, fibroid attached by pedicle to uterus, etc.

The treatment is surgical by radical excision. Where these tumors reach a large size it is sometimes necessary to do an extensive resection to close the opening left. These tumors are generally benign tumors. It seems to be evident that these individuals are predisposed to an over-development of connective tissue. Balfour, of the Mayo Clinic, reports seven cases in the *Railway Surgical Journal*, and in two of these the tumor occurred in previous operation scars.

Case No. 273.—A young woman twenty-four years of age presented herself for examination. She complained of having a tumor which had been getting gradually larger since her first child was born five years ago. She stated that one doctor had informed her that she had a tumor of the ovary. She said that the tumor was getting so large that it interfered with her work. It was also beginning to be painful.

Personal history was negative. Menstruation began at eleven. Was married at the age of seventeen. Had two children, both living. There had been no menstrual disturbance at any time. Physical examination showed a tall robust young woman. Heart and lungs negative. A large tumor occupied the entire left side of abdomen. This tumor seemed to be in the abdominal cavity because of the growth inward.

Uterus and appendages were normal upon examination. Urine and blood examinations were negative. At first it was rather difficult to make a diagnosis because the tumor seemed to be intra-abdominal.

February 16, 1917, at St. Elizabeth's Hospital under ether anæsthesia, the tumor was excised, and with it was included the entire left rectus muscle with the fascia and peritoneum covering it. This left a large opening which had to be closed. This was accomplished by resection of the various abdominal layers and closing the same as in any hernia of the abdominal wall. The recovery was uneventful excepting a persistent drainage for several weeks (probably due to fat necrosis or oozing), which finally healed with a good serviceable abdominal wall. The tumor (Fig. 1) weighed twenty-two ounces.

The pathological report from Dr. George Covey is as follows:

Grossly the tissue appears somewhat gelatinous, yet firm to the touch. Microscopically, the fragment taken from the ventral portion of the tumor shows a typical myxofibroma (Fig. 2). The fibrous tissue is in excess of the myxomatous and spider cells are seen only in small isolated areas. There are no remnants of muscle tissue.

The portion from the dorsal aspect of the tumor contains one fair sized bundle of muscle fibres. They are, however, undergoing degeneration, as shown by shrunken nuclei and fragmenting and granular cytoplasm. At the edges of the bundle there is replacement of the muscle by fibrous tissue (Fig. 3) and in the surrounding tumor mass are isolated fragments of degenerating muscle cells.

FIG. 1.—Fibroma of rectus, peritoneal surface.

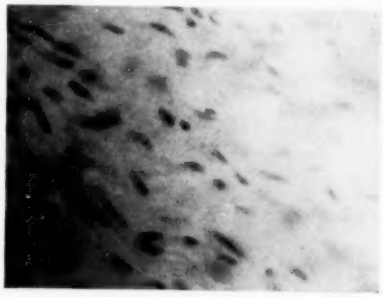

FIG. 2.—High-power photomicrograph of the myxofibromatous tumor mass replacing the right rectus muscle.

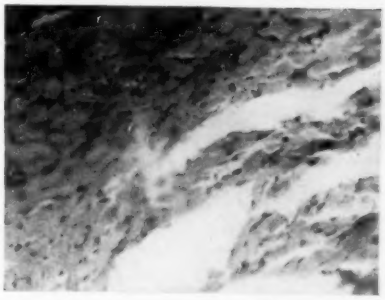

FIG. 3.—Photomicrograph of remnant of muscle (rectus) along the dorsal side of tumor. This area is surrounded by the myxofibromatous tumor mass.

# GALL-STONES IN INFANCY AND CHILDHOOD

By Daniel N. Eisendrath, M.D.

of Chicago, Ill.

So few cases of cholecystitis with or without calculi occurring below the age of twenty have been published that it may be of interest to report the following two cases, both in girls of fifteen.

Case I.—Girl of fifteen admitted to my service at the Michael Reese Hospital on May 19, 1914. Her illness had begun one year before with pain in the right hypochondrium, which radiated toward the left and around to the right shoulder. The first attack lasted ten hours, during which time she vomited once. During the year preceding her admission there had been a number of similar attacks, during several of which jaundice of a slight but distinctly noticeable degree had been present. The attack on account of which she had been sent to the hospital had begun suddenly four days before with severe colicky pain in the right upper quadrant of the abdomen, radiating in a backward direction and towards the left. She had vomited at frequent intervals during the three days before admission. There had been no jaundice present during this attack. There had been no history of typhoid, the patient having lived in the Home for Orphans for a number of years under the careful observation of Dr. May Michael who sent her to the hospital. The abdomen when first examined by the writer was markedly rigid and tender in the right upper quadrant. The white blood count was 20,000, 87 per cent. of which were polymorphonuclears. Rectal temperature 101.2° F. A diagnosis of acute cholecystitis was made and operation advised on account of the frequency of the attacks during the year preceding her admission.

Under anæsthesia one could palpate an ovoid mass extending about two inches downward from the right costal margin, which was considered to be a greatly distended gall-bladder. This was confirmed when upon opening the abdomen, a gall-bladder about the size of a lemon was found tensely filled with fluid and with omentum lightly adherent to it. The serosa was intensely red and œdematous as far down as the common duct. There was an acutely enlarged lymph-node at the neck of the gall-bladder and the walls of the organ were very thick. The common duct was found small and negative to palpation. Upon opening the gall-bladder a large amount of thin purulent fluid under great tension and a number of facetted cholesterin calculi escaped. About fifty of these were removed, four of which were found in the greatly dilated cystic duct.

Cholecystectomy was done on account of the evidences of advanced chronic inflammatory changes in the walls and the danger of recurrence of calculi. The examination of the gall-bladder after removal revealed numerous hemorrhagic and gangrenous areas in the mucosa. The cystic duct, although much dilated, did not show these changes. The walls were greatly thickened and œdematous throughout. Patient made uneventful recovery. This case is of interest because of the acute infection supervening upon a chronic cholecystitis with calculi in a girl of fifteen, whose history of recurrent attacks dated back over a year.

CASE II.—Girl of fifteen admitted to my service at the Michael Reese Hospital on July 7, 1916, suffering from severe pains in the right upper quadrant of the abdomen which had begun about eighteen hours before. Vomiting at frequent intervals accompanied the pain. She gave the history of having had six similar attacks lasting from ten to sixteen hours during the year preceding the present attack. There was no history of typhoid. Examination of the abdomen showed marked tenderness and rigidity over the right iliac region and a tense, tender mass like a distended gall-bladder in the right hypochondrium. The white blood count was 20,800, rectal temperature 100.5° F.

The diagnosis rested between acute appendicitis and acute cholecystitis, or the simultaneous presence of both conditions. The age of the patient (fifteen years) would have made me hesitate to make a diagnosis of cholecystitis with or without calculi, had it not been for the fact that the mass to be felt in the upper abdomen was quite distinct from the rigidity and tenderness of the right iliac region. A right rectus incision was made so as to be able to examine both the appendix and gall-bladder. The latter was found to be the size of a large pear very greatly distended, with marked œdema of the tissues around the neck of the gall-bladder. When the viscus was opened a large quantity of mucoid fluid escaped as if under great tension. Ten cholesterin, pea-sized calculi were found, one of which had completely blocked the cystic duct and caused an "acute hydrops" of the gall-bladder. On account of the danger of recurrence of infection, the gall-bladder was removed. Its walls were very œdematous and the mucosa showed a diffuse redness due to many hemorrhagic areas.

The appendix was removed and upon opening it a stricture was found at its middle with much clear mucus under tension and thickening of the walls distal to the narrowing. There were a number of punctate hemorrhages in the mucosa of the outer half of the appendix and roughening and injection of the serosa.

The patient made an uneventful recovery. The two most interesting features of this case are the age of the patient and the concomitant presence of an acute cholecystitis with many calculi and of an acute exacerbation of a chronic appendicitis.

Up to 1913 Khautz [1] was only able to find the reports of 15 cases. Of these 5 were autopsy observations, one case was in a new-born infant and in only 9 cases was the diagnosis confirmed by operation.

The symptoms did not differ from those in adults. All of the patients above the age of thirteen were girls. In 4 of the 9 cases which were operated, calculi were found up to 20 in number.

Wharton [2] found an acute empyema of the gall-bladder in a girl of fifteen, three weeks after an operation for acute appendicitis, showing the concomitant presence of infection in the gall-bladder and appendix as in my second case. Only one case [3] has been reported since the article by Khautz, making a total of thirteen cases, including the above two of my own in which the diagnosis was confirmed at operation.

[1] Zentr. f. d. Grenzg. d. Med., 16, 546, 1913.
[2] Trans. Am. Surg. Assn., 1909.
[3] Semaine Med., 22, 790, 1913.

# NOTES ON FOUR KINDS OF APPENDICITIS*

By Robert Tuttle Morris, M.D.
of New York

*Appendicitis Irritans.*—The commonest form of appendicitis appears to represent an irritative lesion and not an infective lesion. It was named "appendicitis obliterans" by Senn, whose contribution to the subject appeared in *The Journal of the American Medical Association* in 1894. Senn believed this condition to depend upon a relapsing infection of mild degree, followed by tissue changes resulting in final disappearance of normal structures of the appendix. He held that the condition called for prompt operation.

In the previous year, Ribbert (*Virchow's Archiv,* 1893) had described the same condition in a different way. He believed it to represent an involutional process that was not pathological. In advance of Ribbert and of Senn, Fitz, in 1886, refers to obliteration of the appendix as a result of previous inflammatory processes.

Disagreement on the part of these three early writers led me to make an independent study of the subject, and my own conclusion included the idea that in cases of appendicitis obliterans we were dealing with a normal involution process belonging to a vestigial structure. The subject appeared to belong to ontogeny rather than to pathology fundamentally. The pathology of obliterating appendicitis seemed to be incidental to the presence of nerve elements persisting in the midst of hyperplastic connective tissue which was undergoing contraction. Irritation of the fibroid appendix nerve elements is not very different from irritation of nerve elements in any sort of scar tissue. A local leucocytosis occurs, local discomfort follows, sympathetic nerve ganglia become excited and excitation of sympathetic nerve ganglia leads to afferent and efferent response by way of the spinal cord centre. Disturbance of the innervation of the entire gastro-intestinal tract may then follow in certain susceptible patients.

Early involution of the appendix seems to occur most frequently in patients who show other stigmata of physical decline, such as narrow costal angles, crowded teeth, gunstock scapulæ, or a defective helix of the ear. Such patients belong commonly to the neurasthenic group with relaxed peritoneal supports. For that reason an irritative appendix has led many a surgeon into the trap of believing that removal of the appendix in such a case would dispose of other symptoms belonging to the general condition of a neurasthenic patient. Personally, I have not escaped the trap. An advanced degree of involution of the appendix does not belong to the very young but the process may be

* Read before the New York Surgical Society, May 9, 1917.

found under way in perhaps one-third of all appendices in people twenty years of age. Ribbert found that more than fifty per cent. of all appendices were obliterated in people past the age of sixty years.

In specimens which I examined obliteration appeared to begin most frequently at the distal extremity of the appendix and to consist in gradual replacement of all structures of the appendix by hyperplastic connective tissue. The mesentery of the appendix took part in the involution process with final disappearance of its structures. In advanced cases the appendix consisted of little more than a fibrous string, resting behind flattened peritoneum.

It is my belief that the presence of abundant new cells in appendices undergoing involution obliteration is due to irritation of nerve elements by contracting connective tissue, rather than to the presence of bacteria or their toxins. It is my feeling that an appendix undergoing the process of fibroid degeneration (involution obliteration) is particularly safe against infective invasion, and for two chief reasons.

The first reason includes the idea that structures which would be injured in the course of bacterial invasion are gradually disappearing from the appendix which is yearly becoming more and more fibrous.

In the second place the irritative feature calls out a local hyperleucocytosis which is more or less protective against bacterial assault upon appendix tissues. For this reason I have sometimes referred to irritative appendicitis as " protective appendicitis " when making contribution to the literature of the subject. The patient appears to be protected against the dangers of acute infective processes at least.

It is a fact that a low grade inflammatory process with many bacteria present involves the mucosa in some cases of irritative appendicitis. Whether the obliteration process is hastened by this inflammatory feature or whether the inflammatory process is incidental to lack of resistance on the part of structures undergoing involution I cannot say. The definitely determined fact that abundant new cells are found in appendices which for years have lost their mucosa and other normal structures altogether would seem to offer ground for my belief in the irritative character of the lesion as opposed to the idea of an infective feature playing chief causative part.

Fig. 1 represents a cross-section from a case of irritative appendicitis in which the mucosa has become entirely replaced by connective tissue. The lumen is obliterated, but round-cells are to be observed in the centre of the mass.

The chief symptoms of irritative appendicitis are the chief symptoms of any form of chronic appendicitis and different from the chief symptoms of any form of acute appendicitis. Placing symptoms in the order of their importance we have: (1) Hyperæsthesia of the right lumbar sympathetic ganglion, situated about one and one-half inches to the right of the navel and a trifle caudad, near the spinal column.

(2) Distention of the ascending colon with gas. (3) Transitory pains in the appendix region, not important enough to send the patient to bed, but often sending him to the doctor's office.

Concerning the first symptom: Why should there be hypersensitiveness of the right sympathetic lumbar ganglion, when there is no direct nerve connection between the appendix and this ganglion? I believe it to be due to an efferent impulse which goes out from the spinal cord centre by way of sensorimotor synapsis to this ganglion, as well as to the skin in the Head zone for the appendix. An efferent impulse sent from the irritated appendix to the cord centre is thus manifested symptomatically in two ways by the efferent response.

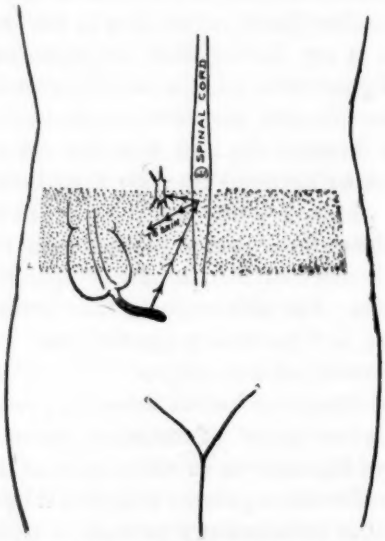


FIG. 2.—Diagram to show lines of efferent impulse going out from the cord centre.

Fig. 2 is a schematic drawing indicating the way in which two lines of efferent impulse go out from the cord centre. One nerve path leads to the skin in the Head zone for the appendix, the other nerve path leads to the right lumbar sympathetic ganglion. Irritation of the right lumbar sympathetic ganglion does not end the history of disturbance referred along sympathetic nerve paths, but I shall stop at this point in the present paper in order to concentrate attention upon the diagnostic value of hyperæsthesia of the ganglion in question.

Concerning the second diagnostic point: Why should there be distention of the ascending colon with gas? We may postulate that the irritated appendix overstimulates the innervation of the ascending colon until the muscularis of this part of the colon becomes more or less exhausted from persistent nagging. When in this exhausted condition the ascending colon is more or less flaccid and it readily becomes a receptacle for gas.

FIG. 1.—Irritative appendicitis. Mucosa entirely replaced by connective tissue; lumen obliterated.

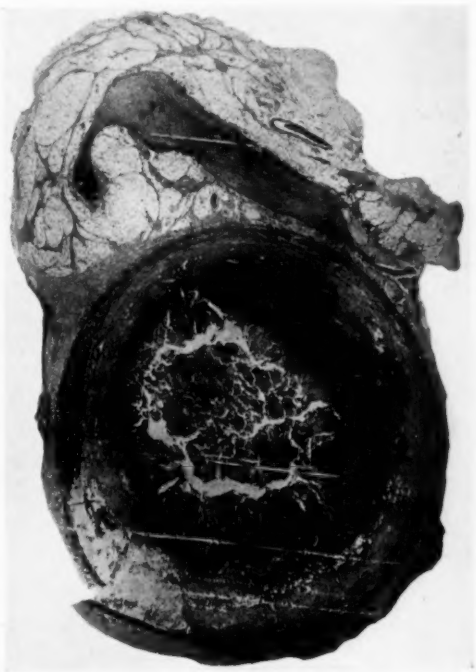

FIG. 4.—Acute intrinsic infective appendicitis. Lumen filled with purulent exudate; mucosa necrotic, distended muscular coats partly necrotic.

FIG. 5.—Extrinsic infective appendicitis dependent upon invasion from a tuberculous peritonitis; inflammatory process localized upon the peritoneal coat where there is an abundance of granulation tissue and chronic inflammatory cells.

FIG. 6.—Syncongestive appendicitis. Note the degree of congestion and œdema with relatively slight cellular infiltration.

Fig. 3 is a drawing from the radiograph of a case of irritative appendicitis. It illustrates the condition of a wearied ascending colon, tired out by persistent over-stimulation from nerve elements irritated in the contracting connective tissue of the appendix. The distention of the ascending colon is readily diagnosticated by ordinary percussion. The percussion note of the right side of the abdomen in these cases is suggestive of the percussion note of a cider barrel in January. The percussion note of the left side of the abdomen in these cases is suggestive of the percussion note of a cider barrel in October. If we keep in mind the picture of the different percussion notes of a cider barrel in October and in January, the diagnostic value of this sign will be given its proper value in cases of irritative appendicitis or of chronic appendicitis of any sort, but not of appendicitis of an acute infective kind. The latter has not had time to weary the ascending colon with

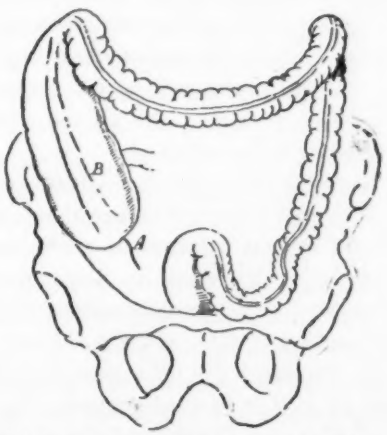


FIG. 3.—Outline constructed from a radiograph of a case of irritative appendicitis, showing distended ascending colon wearied by over-stimulation from nerve elements irritated in appendix.

persistent nagging. Although Senn was the first to give a definite name to normal involution of the appendix, his term of "obliterating appendicitis" does not seem to ring quite true to the facts. His nomenclature carries the idea that it is an "itis" which causes the obliteration.

As I look at the matter the "itis" does not cause the obliteration. The "itis" appears to be incidental to irritation of nerve elements entrapped in connective tissue in an appendix which is becoming obliterated in the course of a normal involution process. Should this view of the situation be verified by other observers a convenient name for the condition might be the one employed in this paper, "appendicitis irritans." The term would not define exclusively because syncongestive appendicitis and the scar tissue left after acute infection of the appendix would remain for classification among irritative lesions. These two lesions, however, represent minor phases of larger conditions which are sufficiently well described in their respective categories.

Hence, "appendicitis irritans" will serve at least for convenience in nomenclature when applied to a condition in which the irritation phase has major value throughout the entire history of a case.

Concerning diagnostic point number three: Why are the pains in the appendix region transitory and not continuous? Presumably because in the presence of any chronic irritation a certain degree of immunity is developed. This immunity varies with so many factors in the general condition of the patient that we cannot say why the pain should be present on one occasion more than on another. We may recognize the fact, however, and employ it for our purposes. There is no need in this brief paper for describing the incidental gastro-enteric disturbances which go with irritative appendicitis. Such disturbances are due in part to the presence of the irritated appendix and in part to faulty organic processes belonging to the habitus of the kind of patient who is most prone to have fibroid degeneration of the appendix. Patients with irritative appendicitis will obtain many opinions from many doctors. The question of operation is one requiring nice judgment and a guarded statement about the prognosis of the patient's condition after operation. Some patients find that the fibroid appendix was not a dominant factor in their troubles after all.

*Acute Intrinsic Infective Appendicitis.*—In this particular contribution to the subject little need be said about the form of appendicitis which has attracted the largest measure of attention. It has engaged attention because of the violence of its demonstration, rather than because of its frequency of occurrence as compared with the irritative lesion of fibroid degeneration of the appendix. Acute intrinsic infective appendicitis has come to stand for all appendicitis by synecdoche in the professional mind as well as in the lay mind. For this reason there is much confusion of idea and blurring of the picture when a patient with any one of three other kinds of appendicitis goes to a consultant who has not made clear mental definition of types of appendicitis. The acute intrinsic infective type of appendicitis appears to stand in second position as regards frequency of occurrence. It is my belief that acute intrinsic infective appendicitis depends upon more than one causative factor, yet all causative factors lead toward two determining phenomena. Rosenow has demonstrated the fact that the appendix tissue shows elective affinity for certain toxins appearing in the circulation and proceeding from some distant focus of infection. Waste products in the circulation also may belong among toxic products. We know that an extension of inflammation of various kinds from the cæcum into the appendix may engage the appendix in a particular response of its own peculiar kind. We know further that the presence of entozoa or of concretions may excite local inflammation of the appendix. We know that angulation or any other form of damming of the proximal end of the appendix may lead to retention of contents

which then undergo decomposition, with the production of toxins capable of producing direct toxic destruction of cells. At this point I would call attention to two peculiar features belonging to the appendix and distinguishing its infective inflammatory history from the inflammatory history of other parts of the bowel.

*A.* The soft elastic inner coats of the appendix cannot swell readily within the less elastic outer sheath of peritoneum, when swelling has been caused by elective affinity for toxins, by extension of inflammation from the neighboring cæcum, by the irritation caused by foreign contents, or by damming of the outlet of an appendix lumen. The swelling inner coats suffer from compression anæmia because of their inability to expand freely within the comparatively inelastic outer sheath of peritoneum. Tissues which are anæmic from compression or from any other cause have lost their normal degree of resistance to bacterial invasion. They are no longer protected by the defence mechanism elaborated rapidly when blood and lymph transportation of defence materials occurs freely in the presence of infection.

*B.* The other distinctive feature belonging to acute intrinsic infective appendicitis consists in proliferating endarteritis of the blood-vessels of the appendix. The appendix is a long peninsula having but one chief line of communication for supplies. It is cut off from these supplies when blood-vessels of its mesentery are engaged in proliferating endarteritis.

Proliferating endarteritis involving a part of bowel wall elsewhere may not be seriously destructive because of the freedom of collateral circulation, but in the appendix peninsula such collateral circulation cannot be fully effective under normal anatomic conditions in pathologic state. The symptoms and treatment belonging to acute intrinsic infective appendicitis are not described in this paper.

Fig. 4 is from a cross-section of a case of acute intrinsic infective appendicitis. The walls of the lumen are dilated and filled with purulent exudate. Mucosa is necrotic, inflammatory cells extend through the walls and out upon the serosa. The distended muscular coats are partly necrotic. Rhexis and œdema are in evidence.

*Extrinsic Infective Appendicitis.*—This form of appendicitis is due to extension of infection from some other structure in the vicinity (ovarian abscess, pyosalpinx, or tuberculosis of the peritoneum, for example). Infection extending from other structures includes the appendix extrinsically. The tissues of the appendix in such case having been forewarned are forearmed. The armed peritoneal coat forbids development of rapid changes in the soft inner coats leading to fatal compression anæmia or to direct toxic destruction of cells. In a typical case of extrinsic infective appendicitis, the appendicitis is of secondary importance and is frequently discovered for the first time by the surgeon who is operating for the relief of

some other condition. It is not so often discovered by the diagnostician in advance of operation. The reason for that is because the infection which happens to include the appendix in its range is presenting symptoms of its own kind in major rôle at the moment.

Sometimes the complication of extrinsic infective appendicitis becomes the prime feature of a case, but this is not the rule. The history of a case of acute extrinsic infective appendicitis is different from the history of a case of intrinsic infective appendicitis not only because of a different kind of response to infective invasion, but also because adhesions have often formed in such a way as to allow fairly good blood or lymph circulation for the tissues of an extrinsically infected appendix.

Fig. 5 is from a case of extrinsic infective appendicitis dependent upon invasion from a tuberculous peritonitis. The inflammatory process is localized upon the peritoneal coat where there is an abundance of granulation tissue and chronic inflammatory cells.

*Syncongestive Appendicitis.*—One kind of irritative lesion and two kinds of infective lesion of the appendix have been described so far in this paper. Syncongestive appendicitis is a term that I have applied for convenience in nomenclature to a second and quite distinct irritative lesion. The term, " appendicitis syncongestiva," is an appellation which may help one to carry in mind the idea of an appendix which is congested synchronously with ordinary congestion of other structures in the vicinity. This may occur with many forms of obstruction to the blood and lymph circulation of the cæcum and ascending colon. For example, it is a common complication of general enteroptosis.

The reason why the appendix presents symptoms of its own peculiar sort in cases of sycongestive appendicitis is probably because the soft inner coats of the appendix attempt to swell within the less elastic outer sheath. For that reason, perhaps, there is pain at the appendix site; pain which would not appear at any readily distensible part of the bowel.

In cases of syncongestive appendicitis the factor of special compression anæmia may really lessen the defence apparatus of soft inner coats of the appendix, very much as it does in cases of infective lesions of the appendix because anæmic tissues are particularly vulnerable to bacterial invasion. On the other hand, the defence mechanism acting throughout the entire cæcum, ascending colon and appendix simultaneously appears to protect the appendix fairly well in cases of syncongestive appendicitis. In other words, the appendix swelling appears to rise and fall along with the swelling of cæcum and ascending colon. The expression, " rise and fall," applies particularly to the question of interstitial infiltrates.

Fig. 6 is from a case of syncongestive appendicitis occurring in a young man sent to the hospital with a diagnosis of paratyphoid fever.

This specimen shows a serous infiltration of all structures of the appendix. There is also some cellular infiltration consisting principally of eosinophiles. Subserous blood-vessels are dilated. The particular feature of the case rests in the degree of congestion and œdema with relatively slight amount of cellular infiltration.

Painful symptoms in the appendix region attracted more attention than did other symptoms in this case, and it was deemed advisable to remove the appendix. At the time of operation the ascending colon and cæcum were found to be involved in a similar form of inflammation. Removal of the appendix was probably unnecessary, although it did not happen to be harmful. Cultures taken from areas of pyorrhœa showed that this patient was suffering from an overwhelming dose of streptococcus viridans. Inflammatory abdominal symptoms gradually subsided when attention was given to the focus of oral infection that had been manifesting itself apparently by way of elective affinity on the part of the enteron.

The appendix disturbance presented features of an irritative lesion rather than those of an infective lesion. The irritative lesion of syncongestive appendicitis occurs most frequently in various chronic obstructions of the blood and lymph circulation, but this particular specimen from a case of acute inflammation happens to be the only one which I had at hand at the time of preparation of the paper.

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# ENTEROSTOMY AND THE USE OF THE OMENTUM IN THE PREVENTION AND HEALING OF FISTULA*

By Charles H. Mayo, M.D.
of Rochester, Minnesota

The operation of enterostomy is a life-saving procedure the necessity for which may be discussed a few hours longer than that of making a tracheotomy. When indicated, it is just as much an operation of necessity or emergency as the latter. Both procedures have indications and marked limitations for obstruction which is mainly mechanical.

Obstruction of the bowels may result from the toxemia of disease, either local or general, or from adhesions or paresis due to acute or chronic local or diffuse abdominal inflammation. A loop of bowel may become caught beneath a peritoneal band formed from some old infection long since healed. Conditions resembling intestinal obstruction may occur from reflex causes secondary to acute diseases of the kidney.

In the large majority of cases the intestinal obstruction for which the operation of enterostomy is indicated occurs during the first few days following an abdominal operation. The obstruction may be in the large or the small bowel; when in the large bowel a longer time is given for discussion as to its cause and method of treatment; the danger from toxemia is not as serious as in obstruction of the small bowel. In colonic obstruction the danger is from exhaustion or peritonitis resulting from perforation. Visible peristalsis extending irregularly over the abdomen is often noted. Such peristaltic waves are less noticeable in obstruction of the small bowel unless the obstruction is low in the ileum, and is incomplete and chronic. The danger of colonic obstruction following operation is greater when the operation has necessitated any suturing of the bowel. The lower the injury in the intestine the greater the danger of infection from the suturing of the bowel because of the difference in the type of bacteria commonly found in varying portions of the intestine. In the small intestine there is the added toxæmia of retained secretions and ferments which are delivered to the blood through the lymphatics without the protective influence of the liver which is exerted over the absorbed secretions of the colon (Draper).

In certain abdominal operations involving suturing of the middle or left colon an appendicostomy may be made as a safety-valve to take strains off the suture line, or a small tube may be passed into the rectum, high in the sigmoid, and left there during the first few days following the operation.

After abdominal operations there is usually stasis of peristalsis during the first twenty-four hours. This follows the injury of the peritoneum and is a protective measure occurring after the perforation of ulcers, gunshot wounds, or other abdominal injury, and giving time for the formation of life-saving adhesions.

* Presented before the American Surgical Association, Boston, June 1, 1917.

In children, abdominal operations are performed chiefly for one definite purpose and exploration is rarely indicated. In adults, the diagnosis of the essential lesion may be most accurate, yet complications or other disease may be present. It is, therefore, best in most cases other than acute infections to explore for associated disease even though such examinations may be the cause of additional gas colic and stasis following operation. A patient who has had an abdominal operation will probably have some stasis the same day and it should not occasion worry if the condition persists until the next night, even though it may be the cause of considerable pain. Various enemas are given the day following the operation, usually with complete relief. If the patient is not relieved, lavage laxatives, different kinds of enemas, hypodermic injections of pituitrin or eserin are given during the second night and third day. If these do not bring relief it may be concluded that the obstruction is complete. The patient vomits and is toxic from the small bowel secretion. The evening of the third day or the morning of the fourth he is taken to the operating room, the sutures are removed, the incision opened and the abdomen inspected. When there is general peritonitis the intestines are red and inflamed or lymph-covered. In such cases an enterostomy is made without exploration. If there is no evidence of general peritonitis the hand is inserted and passed to the site of the operation, which, in acute or chronic abdominal sepsis, is usually in the pelvic or right iliac region. In the search for obstruction at this early stage the adhesion causing the condition readily gives way and the gurgling of moving gas is felt and heard. When this occurs, enterostomy is not required. If operation is delayed until late in the fourth day, or even later, there may be toxic paresis as well. In some cases local abscesses are formed, but practically all patients who survive usually recover from the obstruction spontaneously with natural movements eight days from the day of its occurrence, life having been saved by the safety-vent. Patients with obstruction beginning some days following operation usually present the same symptoms at the same period from the day the obstruction began. In such cases bands of adhesions are the principal factor.

Enterostomy is less favorable for diffuse peritonitis than for localized obstruction. In the colon, obstruction is relieved by appendicostomy, cæcostomy, colostomy or the Brown operation of ileostomy. There is rarely spontaneous recovery from obstruction of the large bowel, a second operation being required for permanent relief and the restoration of the anal function.

Technic.—In early operation reopening of the incision is preferable. The advantage of this is that little or no anæsthetic is required for the whole procedure. In late operation a second incision is occasionally advisable. A low-lying loop of distended bowel is elevated into the incision. A segment is freed of gases or fluids and controlled by rubber-covered forceps applied above and below the point selected for perforation. At a point opposite the mesentery a purse-string suture of silk is applied in a diameter of half an inch. The bowel is perforated in the centre of the

purse-string by a knife, or the perforation may be made by the method of J. W. Long, using the Paquelin or an electric cautery. A catheter, size 10 or 12, is inserted several inches into the intestine and held in place, after the purse-string is tied, by perforating its side with the same needle and tying it into place. This suture will hold for a few days only. It will then cut out of the tissues and may be removed with the catheter when the latter is withdrawn. Two successive purse-string sutures may be applied by the Stamm-Kader method, but the procedure most satisfactory is that of Witzel, *i.e.*, depressing the catheter into the wall of the bowel and suturing together the folds thus formed over the catheter for a space of an inch and a quarter. When the operation is made as a jejunostomy for feeding or for intestinal obstruction in children the Coffey method of incising the peritoneal and muscular layers of the bowel at the point of depressing the catheter into its wall conserves the lumen of the gut, the tube being placed between the mucosa and the wall of the intestine, and the peritoneum and muscle being approximated over the catheter. This method is rarely followed by a fistula. For additional security and also to favor closure of the opening, we have passed the catheter through the perforated omentum (Fig. 1) and then for fixation have included the parietal peritoneum, the omentum and the intestine in three sutures. This method maintains a movable, even if adherent, intestine and the omental graft aids in closing the bowel opening by granulation.

Two unfortunate conditions may occur: (1) The loop of bowel chosen for the opening may be high in the jejunum, leaving but a limited length for nutrition. In this case rectal feeding (intravenous or subcutaneous infusions of saline) will aid until the adhesions subside and relief is obtained. (2) A fistula may occur at the point of enterostomy when it is made without the protection of the omentum. Should a fistula occur it may be blocked by inserting through it into the intestine an oblong button held by threads in the eyes or through a perforation in the obturator which hold it up against the wall of the bowel at the point of leakage; the threads are then passed through the perforations of a flat button on the skin side of the fistula. This method makes a closure until granulations fill the opening, when the thread can be cut and the inner button passes with the intestinal contents (Dowd, Pallister).

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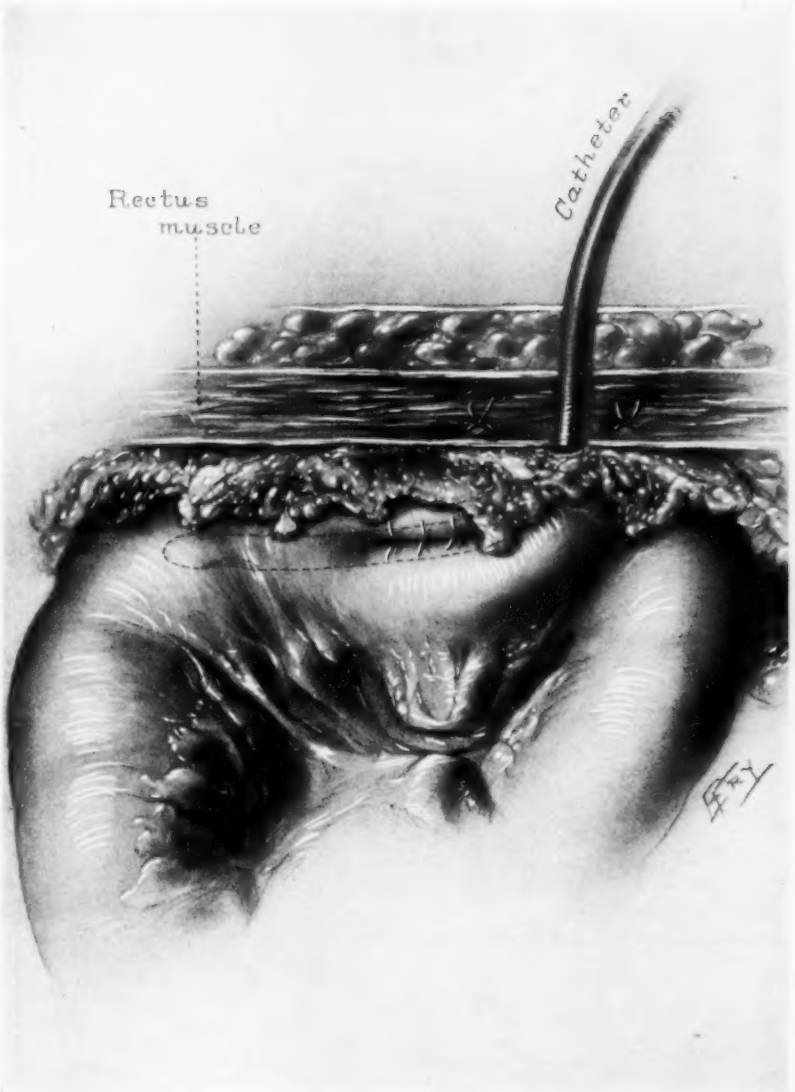


FIG. 1.—Tube passing through the abdominal incision and the omentum and into the lumen of the bowel.

# HISTOPATHOLOGY OF CARCINOMA OF THE TESTICLE

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The morphological study of malignant tumors arising in the various glandular structures of the body has led in most instances to a satisfactory classification and a more or less definite knowledge of their histogenesis. Malignant tumors of the testicle have been carefully studied and in spite of many painstaking investigations, some of very recent date, a classification based on their histogenesis is still not definitely established. This fact led us to the study of these neoplasms with the idea, if possible, of identifying the types of malignant tumors of the testicle and of arriving at a satisfactory classification. In our series of cases we were unable to study any true sarcomata of the testicle and feel that we are unable to add anything definite to the various theories as to the origin of true teratomata. Our observations, therefore, will be limited to the question of the classification and histogenesis of carcinoma testis.

Langhans in a study of twenty-seven so-called alveolar carcinomata found only two containing cartilage and presenting other characteristics which would lead one to classify them as teratomata. The remaining twenty-five he describes as alveolar tumors with large polyhedral or polygonal cells, the protoplasm of which is somewhat granular and pale staining, the nuclei round or oval and vesicular in character. The stroma, which varies in amount, contains blood-vessels surrounded by leucocytes and occasionally infiltrated by lymphocytes. He believes that these tumors arise from the follicular epithelium of the seminiferous tubules and that the rete and straight tubules are only secondarily involved. When the latter are involved they may give rise to adenomatous or papillary carcinomata. He has pictured transitions from the tubular epithelium into true tumor and uses this observation as evidence to support his view that the tumor is a carcinoma arising from the tubular epithelium.

Wilms in a careful analysis of ten tumors finds that in many so-called mixed tumors we are really dealing with teratomata containing products of all three germinal layers. He admits the possibility of

* This study was carried on under the tenure of a Eugene Meyer, Jr., Fellowship and a Moses Heineman Fellowship.

carcinomatous change in them but also contends that pure carcinoma may exist as an independent tumor arising from the seminiferous tubules. This latter contention, however, he is unable to prove.

Chevassu also found that the so-called mixed tumors are really tridermal teratomata. He mentions the possibility of overgrowth of one of the teratomatous elements which in extreme cases may completely dominate. Malignant transformation in the form of various types of carcinoma is also described and the author has in these instances found the tumors to be papillary in structure. He further carefully studied a type of tumor which he termed "seminome," believing it to arise from the spermatogonia. He differed from the opinion offered by Krompecher that these tumors were endotheliomata, and likewise disagreed with Monod and Terrillon as to their histogenesis. The latter authors considered these tumors to have their origin in the embryonic remains of the germinal epithelium. Chevassu differentiated quite definitely the so-called "seminome" from the lymphadenomata and lymphosarcomata. In contradiction to Hansemann he could find no evidence of relationship between these tumors and the interstitial cells of the testicle. He believed that these tumors arose from the cells of the seminiferous tubules nearest the basement membrane, because of the morphological, tinctorial, and chemical resemblance existing between the tubular cells and the tumor cells proper. He further believed that the illustrations of Tiggonie, Talavera, and Langhans showed definitely the transitions of certain seminiferous tubules into tumor. He himself could not find such transitional areas because of the advanced stage in the development of the tumors that he studied.

Debernardi in a study of four cases of large cell tumor of the testicle comes to the conclusion that these tumors are epithelial in origin and arise either from the developed cell of the seminiferous tubule or from the anlage of this structure. In an additional case he found carcinoma in a testicular teratoma with metastatic carcinoma in various organs, the metastases resembling the large round cell neoplasm found in the testicle. It seems probable that he was dealing with a metastatic large cell carcinoma of the testicle associated with a typical testicular teratoma (that is, two tumors), rather than with a teratoma that had become carcinomatous and in which the carcinomatous element had metastasized.

After an extensive analysis of eighteen cases Ewing came to the conclusion that all the large cell tumors of the testicle and, in fact, all carcinomata of the testicle are but extreme examples of "one-sided development of teratomata." He based his argument on the fact that in some of his cases of so-called simple tumor, careful study had shown them to be teratomatous in nature. Furthermore, in some of the teratomata he found carcinoma of various types. He claims that the simple carcinoma has a distinct morphology, and because of its resemblance to the carcinomata found by him in teratomata, he considers the simple

carcinomata to be true teratomata in which the carcinoma has completely overgrown every vestige of teratoma.

Sakaguchi believes that the large cell tumors of the testicle arise from the epithelium of the seminiferous tubules, basing his belief on the fact that the study of serial sections has demonstrated the transition from the proliferating epithelium of the seminiferous tubules to the masses of tumor cells. He further describes a type of epithelial tumor with adenomatous structure and papillary proliferations composed of cells smaller than the elements forming the so-called "seminome" and often cuboidal in shape. He believes these tumors might arise from the epithelium of the tubuli recti.

We have studied twenty-six tumors of the testicle and have grouped them according to the following classification:

*Carcinoma*
- Medullary ..... Alveolar, seminome.
- Adenomatous ..... With medullary areas. / Papillary.

*Teratoma*
- Without carcinoma ..... None studied.
- With carcinoma ..... Adenomatous type with medullary or papillary areas.

*Carcinoma.*—Of the pure medullary type we studied sixteen, one of which contained masses of protoplasm with multiple nuclei somewhat resembling syncytium.

Of the adenomatous type we studied four examples all of which presented medullary and papillary areas. One of them contained in addition multinuclear protoplasmic masses similar to those mentioned above.

The medullary carcinoma corresponds to the alveolar carcinoma or "seminome" of other authors. Microscopically, these tumors are composed of masses of large polyhedral cells with pale staining, finely granular, often vacuolated protoplasm containing a large, round or oval, vesicular nucleus. The vacuoles in the protoplasm represent glycogen droplets which can be demonstrated by selective staining. Mitotic figures are of frequent occurrence. These cells are almost identical in appearance with the spermatogonia. The cells are arranged in groups and masses, in some areas mimicking tubules in their development. The stroma is composed of fairly broad connective-tissue strands, separating the larger groups of cells and containing many thin-walled vessels. Occasionally about these vessels and in the stroma lymphocytes and polynuclear leucocytes are found. In some of the neoplasms there seems to be a tendency for the tumor cells to arrange themselves about the blood-vessels, often giving the impression of a perithelial tumor. Finer fibrils radiate from these broad connective-tissue strands, further sub-

dividing the cell masses. There is a marked uniformity in the cell contour and appearance. The adenomatous type differs from the type described above.

We find in these tumors typical adenomatous areas composed of glandular structures lined by cells smaller than those described as characteristic of the medullary type and lacking also the vacuolated pale protoplasm. These cells are cuboidal or cylindrical, often irregular, the protoplasm staining deeply. Here and there solid masses of these cells are encountered and often the adenomatous areas are thrown into papillary proliferations. The stroma in this type is similar to that described in the medullary tumor, but areas of round cell infiltrations are more often encountered.

*Teratoma.*—Six teratomata containing carcinoma were studied. In five the carcinoma was papillary adenomatous in type with scattered nests of malignant cells. In two of this group small multinucleated protoplasmic masses were found.[1] Only one contained purely medullary carcinoma, the cell type resembling that of the alveolar form found independently of teratoma.

The carcinomata which are encountered in teratomata corresponded accurately to the type already described as adenomatous or papillary. We never found a carcinoma in a teratoma that resembled the purely medullary type except in one instance, and in this case the tumor cells were smaller than those usually found.

## Description of Material Studied

### Medullary Carcinoma

*Tumor* 1037.—Specimen consists of a rounded tumor, measuring seven centimetres in diameter, which has completely replaced the testicle. The tumor is surrounded by the intact tunica and on section shows a uniform cellular appearance with a few scattered areas of necrosis.

*Microscopical examination:* Large, polygonal cell, medullary tumor. The cells occur in large nests and strands. Seminiferous tubules are still preserved, some imbedded in connective-tissue strands, others in tumor proper. The cells of these tubules are identical in appearance with those of the tumor. In places tumor and tubules are directly continuous with one another. Origin of tumor from tubules indeterminable.

*Tumor* 2423.—Fixed specimen consists of testicle and adnexa. Testicle is replaced by a tumor, twelve centimetres in diameter. This tumor is enclosed by the tunica. On section, it has a firm, white, cellular appearance, interspersed with bands of hyaline connective tissue.

*Microscopical examination:* Large, polygonal cell, medullary tumor. In places there is definite connection with seminiferous tubules, tumor apparently arising from them.

*Tumor* 2294.—Fixed specimen consists of testicle and adnexa. Testicle has been converted into a firm tumor, seven centimetres in diameter. On section, the tumor is lobulated, the lobules separated by connective-tissue strands. The tumor is surrounded by the intact tunica.

[1] In another, an area of syncytial tissue surrounded by blood-vessels and clot and resembling the picture seen in chorio-epithelioma was present (Fig. 6).

*Microscopical examination:* Large, polygonal cell, medullary tumor, in many places apparently arising from the tubules.

*Tumor* 1244.—Specimen consists of testicle and adnexa. The testicle has been converted into a tumor, measuring ten centimetres in diameter. There are no testicular remains. The tumor is encapsulated by the tunica. On section, the mass is traversed by bands of hyaline connective tissue. The epididymis is enlarged, hard, and apparently involved by tumor.

*Microscopical examination:* Large, polygonal cell, medullary tumor having a tendency to perithelial arrangement.

*Tumor* 2085.—Fixed specimen consists of testicle and adnexa. The testicle has been converted into a tumor, measuring eight centimetres in diameter. On section, the tumor has a cellular appearance, the centre being shaggy and necrotic.

*Microscopical examination:* Large, polygonal cell, medullary tumor. In places the solid alveoli seem contained within the sheaths of the seminiferous tubules and apparently have this epithelium as their source of origin.

*Tumor* 3697.—Fixed specimen consists of testicle and adnexa. The testicle has been replaced by a rounded tumor, measuring nine centimetres in diameter. The tumor is encapsulated by the tunica.

*Microscopical examination:* Large, polygonal cell, medullary tumor with a connective-tissue stroma whose fibrils ramify between small groups of cells.

*Tumor* 1654.—Fixed specimen consists of testicle and adnexa. The testicle has been replaced by a tumor, measuring fifteen centimetres in diameter, which has a small rim of compressed testicular tissue at the upper pole.

*Microscopical examination:* Large, polygonal cell, medullary tumor, which gives the impression of arising from the seminiferous tubules. In some of the areas the cell groups are contained in a limiting connective-tissue sheath resembling tubules. Here, too, the resemblance between the tumor cells and the tubule cells is striking.

In the tumor, areas composed of masses of protoplasm containing many nuclei were encountered.

Tumor 2918.—Typical large, polygonal cell, medullary tumor.
Tumor 5250.—Typical large, polygonal cell, medullary tumor.
Tumor 1620.—Typical large, polygonal cell, medullary tumor.
Tumor 3967.—Typical large, polygonal cell, medullary tumor.
Tumor 10107.—Typical large, polygonal cell, medullary tumor.
Tumor 9285.—Typical large, polygonal cell, medullary tumor.
Tumor 2618.—Typical large, polygonal cell, medullary tumor.
Tumor 1343.—Typical large, polygonal cell, medullary tumor.
Tumor 19344.—Typical large, polygonal cell, medullary tumor.

### ADENOCARCINOMA

*Tumor* 9863.—Specimen consists of testicle and adnexa. Testicle has been converted into a tumor mass, measuring seven centimetres in diameter. It is lobulated, the lobules being separated by connective-tissue bands. The lobules are cellular and somewhat necrotic. The tumor is completely encapsulated by tunica.

*Microscopical examination:* Large, polygonal cell, medullary type of tumor, showing papillary adenomatous areas.

*Tumor* 36.—Specimen consists of testicle and adnexa. Testicle has been replaced to a great extent by a tumor mass, measuring eight centimetres in diameter. The tumor is gray, soft, cellular, and shows areas of necrosis.

*Microscopical examination:* Large, polygonal cell, medullary tumor showing areas of papillary adenocarcinoma. In many places there is a great proliferation

of the cells of the seminiferous tubules, and these have a marked resemblance to the tumor cells constituting the medullary portion of the neoplasm. Areas of apparent transition from tubule to tumor are also to be found. The papillary areas have slightly smaller cells and are circumscribed in their arrangement.

*Tumor* 3417.—Fixed specimen consists of testicle and adnexa. The testicle is normal in size, the centre being represented by a shaggy necrotic mass which has crowded the testicle to one side. The mass has penetrated somewhat through the tunica, but over its greatest extent is surrounded by the tunica.

*Microscopical examination:* Large cell, papillary and medullary tumor. There are areas in the testicle in which seminiferous tubules are seen full of cells resembling the tumor cells.

*Tumor* 2227.—Specimen consists of testicle which has been converted into a tumor, measuring fourteen centimetres in diameter. Delicate hyaline connective-tissue bands traverse it. The centre is represented by a (degeneration) cyst, four centimetres in diameter, the wall being formed by tumor. The entire tumor is encapsulated by the tunica.

*Microscopical examination:* Large, polygonal cell, medullary tumor with areas of papillary adenocarcinoma.

### CARCINOMATA IN TERATOMATA

*Tumor* 1429.—Fixed specimen consists of testicle and adnexa. The testicle has been converted into a tumor, measuring seven centimetres in diameter. The tumor consists of solid, cellular tissue, with hemorrhagic areas, and is traversed by large veins and hyaline connective-tissue strands. Small hyaline islands are seen scattered through the tumor and tiny cysts can be seen on the cut surface. The mass is encapsulated by the tunica.

*Microscopical examination:* The tumor is composed of various types of epithelial cysts, embryonal connective tissue and hyaline cartilage. There are collections of malignant epithelial cells in groups and large nests. The cells are small and polymorphous with small densely staining nuclei.

*Tumor* 2480.—Fixed specimen consists of testicle and adnexa. At the centre of the testis there is a tumor, five centimetres in diameter, surrounded by a thick fibrous capsule which is also infiltrated by tumor.

*Microscopical examination:* The tumor is made up of masses of large, polyhedral cells with eccentric nuclei, in places adenomatous in arrangement. There are small groups of protoplasmic masses in strands with multiple nuclei and also large areas of compressed and hyaline testicular tubules showing no participation in the new growth. There are numerous epithelial-lined cysts of various types.

*Tumor* 3099.—Fixed specimen consists of testicle and adnexa. The testicle has been replaced by a tumor, measuring eight centimetres in diameter. The tumor mass proper contains numerous small cysts isolated and in groups. Between them are small solid areas separated by fibrous strands. The tumor is encapsulated by thickened tunica.

*Microscopical examination:* The tumor is composed of areas of hyaline cartilage and various types of epithelial-lined cysts. The more solid areas are made up of masses of large cells, polymorphous in appearance. Small areas of tissue, syncytial in character, resembling chorionic syncytium, are seen.

*Tumor* 3759.—The testicle proper is represented by a compressed ring of tissue, thickest at the upper pole, where it measures three-quarters of a centimetre. The tumor is separated from the testicle by a definite fibrous capsule. The tumor is composed of solid areas traversed by fibrous bands and containing numerous cysts.

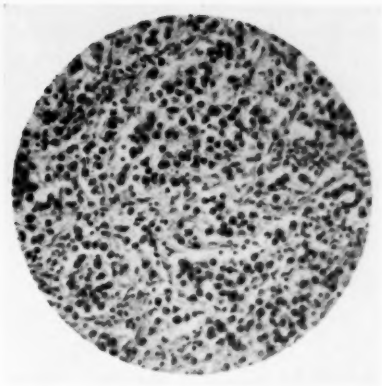

FIG. 1.—Medullary type of tumor, showing alveolar arrangement.

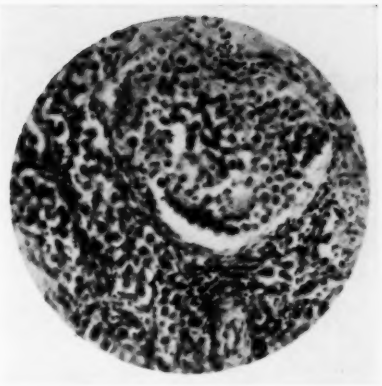

FIG. 2.—Seminiferous tubule surrounded by tumor, illustrating morphological resemblance of tumor and tubule cells.

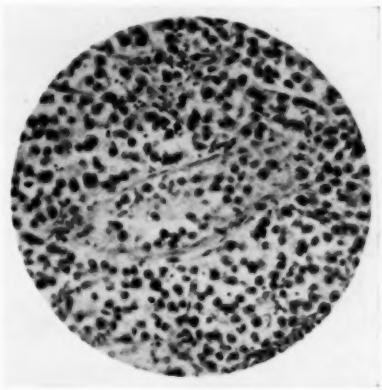

FIG. 3.—Tubule and tumor, showing morphological resemblance of their cells and apparent transition. Tubule into tumor—tumor into tubule.

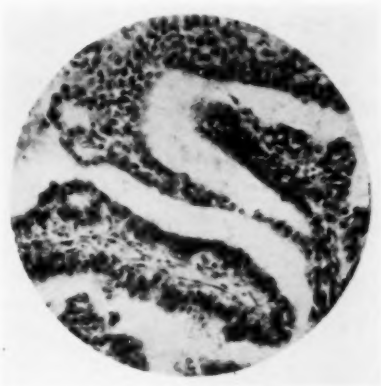

FIG. 4.—Papillary adenocarcinoma found in a medullary tumor.

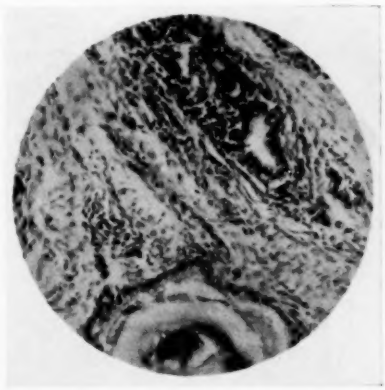

FIG. 5.—Teratoma, showing epithelial cyst (squamous) and adenocarcinoma.

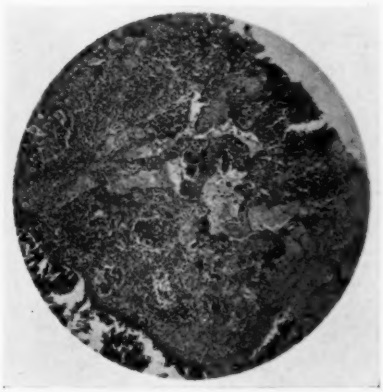

FIG. 6.—Syncytium in intimate relation to an adenocarcinoma found in a teratoma.

*Microscopical examination:* The tumor consists of cartilage and various types of epithelial-lined cysts. There are masses of small, deeply staining epithelial cells with areas of adenocarcinoma. Some areas of the stroma resemble spindle-cell sarcoma.

*Tumor* 58.—Specimen consists of testicle and adnexa. The testicle has been replaced by a tumor, measuring seven centimetres in diameter. It has a cellular appearance and the surface is traversed by bands of connective tissue. To one side is a small encapsulated mass containing small cystic areas.

*Microscopical examination:* The tumors show presence of cartilage and various types of epithelial-lined cysts. There are areas of medullary and papillary adenocarcinoma made up of small, irregular cells with dark, granular protoplasm and deeply staining, irregular nuclei (Fig. 5).

*Tumor* 12612.—*Microscopical examination:* The tumor is composed of areas of cartilage and various types of epithelial cysts. There are also masses of solid and papillary adenocarcinoma. In addition there are areas of multinuclear cells.

## DISCUSSION

A consideration of the views of the various authors cited shows that the most common tumor of the testicle is the large cell alveolar type which has been classified both as a sarcoma and as a carcinoma. The more recent studies of the histogenesis of these tumors have definitely demonstrated that these neoplasms are epithelial in nature (Chevassu).

The twenty non-teratomatous tumors studied by us, with four exceptions, present a complete uniformity of structure, and correspond to the large cell, solid or alveolar tumors, "seminome." We believe, as does Chevassu, that the large cell tumor arises from the epithelium of the seminiferous tubules. The other types of carcinoma might arise from the tubuli recti, although this could not be proven.

The four exceptions mentioned above show medullary, large round cell areas, and in addition adenomatous and adenopapillary portions.

The malignant tumors associated with teratoma we found very different from the solid type just mentioned. As noted previously, these tumors are almost entirely adeno-papillary in structure with scattered small and large nests of malignant cells. The cells are usually cuboidal or high cylindrical, the protoplasm not being vacuolated or granular, and taking an intense stain. The nuclei of these cells are elongated, oval, and usually basally placed. The occasional solid cell nests which are found in these papillary tumors are generally composed of the same type of cell that is found in the papillary portions. The medullary areas in only one tumor resembled the typical "seminome" type of Chevassu.

It would seem probable that in an epithelial organ, such as the testicle, the most frequent type of neoplasm should be epithelial in nature, and as the only truly epithelial elements of the testicle are the seminiferous and straight tubules these tumors would logically be expected to arise from these structures.

The cells of the medullary or alveolar carcinoma correspond closely to the spermatogonia and spermatocytes of the seminiferous tubules and in some of the tumors are identical in appearance, as shown in the accompanying illustration (Fig. 2).

In a few instances the tumor appears to arise directly from the cells lining the seminiferous tubules (Fig. 3). In most of the specimens, however, the tumor has so overgrown the testicle that the source of origin cannot be traced.

The cells constituting the papillary adenomatous malignant tumors associated with teratomata in most instances resemble morphologically those lining the tubuli recti rather than the cells lining the seminiferous tubules.

There remain for consideration the papillary adenomatous portions found in the four cases of medullary carcinoma. These areas are composed of cells not at all resembling those of the medullary portions but are similar to the cells of the papillary adenomatous areas occurring in the carcinomata associated with teratomata.

The origin of the two types of tumor, the medullary and the adenomatous, has not been definitely determined. While we have no absolutely conclusive evidence, we believe that the large cell type of tumor takes its origin from the epithelium of seminiferous tubules, basing our opinion on the morphological resemblance between the cells of the tubules and those of the tumor. We have been able to find areas where the relationship between tumor and tubules is such that the origin of the former from the latter appears most probable (Fig. 3).

The adenomatous type of tumor has the characteristics of adenomatous tumors of other glandular organs (Fig. 4). The cells do not resemble either in morphology or arrangement those lining the seminiferous tubules. The adenomatous neoplasms constitute a type differing markedly from the medullary tumors, and it may not be amiss to suggest that, because of their adenomatous structure and their cell type, they probably arise either from the tubuli recti, or when associated with teratomata, from the glandular structures in the latter.

There is one other possibility to account for the existence of the adenomatous elements so rarely encountered in the medullary tumors. We have seen but four examples of this among twenty specimens. We can accept here either a double source of origin for the two types as described or can suggest the possibility of an adenocarcinoma arising from the seminiferous tubules which, because of their tubular nature, can be conceived of as giving rise to an adenomatous tumor.

Ewing in his study of carcinoma testis has come to the conclusion that all carcinomata of the testicle are a one-sided development of teratomata. He bases his opinion on the following observations. In a number of teratomata he found carcinomata that resembled histologically those carcinomata which occur without the presence of teratomatous

elements. Because of this resemblance he concluded that all carcinomata of the testicle represent teratomata in which the teratomatous elements have been overgrown by the more rapidly growing carcinoma. Not only does he find a similarity in the individual epithelial elements, but the stroma in the tumors, "lymphoid" as he terms it, is similar and is regarded by him as an integral part of the tumor and of value in identifying these neoplasms. As the result of our study we have not been able to classify all carcinomata as one-sided teratomata in their development. Many teratomata testis have been described in the literature in which no carcinomatous elements have been found after a most painstaking search, and, on the other hand, most carcinomata show no evidence of teratoma.

In Ewing's series of eighteen cases of carcinoma, teratomatous elements could be demonstrated in only eight specimens, while in our twenty-six cases only six tumors contained teratomatous structures. In the eight cases in which Ewing could demonstrate teratomatous elements, purely medullary tumors were found only three times, while in five, adenomatous tumors were present. Of these five, two also contained medullary areas. In the six cases in which we found teratoma five of the carcinomata were adenomatous, one only containing medullary areas.

The most frequent type of carcinoma of the testicle is the one described by us as medullary. This is identical with the "seminome" of Chevassu. We find, as does Ewing, that in the teratomata this medullary type is not the usual one.

In our investigation of the various types of carcinoma we studied the character of the stroma, but found that it varies in the different types of tumor. In the adenomatous tumors and in those commonly found in teratomata the so-called "lymphoid stroma" is at times present, while in the pure medullary type it is of comparatively rare occurrence. Because of this variation we are unable to identify the tumor type from the constituents of the stroma.

In view of the fact that the epithelial elements of a teratoma vary in type, it seems to us that a carcinoma arising in such a teratoma would present variations in its structure resembling, more or less, the particular epithelial group from which it took its origin.

However, carcinomata of the testicle, with very few exceptions, can be classified as one simple type, which to us seems to indicate that they most probably develop from a single constantly present histological structure. This, in our opinion, is the best argument for believing that the medullary (large cell alveolar) carcinoma does not represent a one-sided development of a teratoma but is a primary tumor of the testicle itself.

## SUMMARY

1. The commonest type of tumor of the testis is medullary in character, and is commonly described as a large cell alveolar tumor.

2. The cells of the medullary tumors histologically bear a close resemblance to the cells of the seminiferous tubules.

3. There are areas in some of the medullary tumors that suggest direct transition from tubular epithelium to tumor cells.

4. The common type of carcinoma associated with teratoma is adenomatous in character.

5. Adenomatous tumors may have their origin either from the tubuli recti, from adenomatous structures of a preëxisting teratoma or possibly from seminiferous tubules.

6. The medullary tumors we believe are primary tumors of the testicle arising from the seminiferous tubules.

We wish to express our grateful appreciation to Dr. F. S. Mandlebaum, Director of the Laboratory, for his kindness in making the excellent photomicrographs which accompany this article.

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# THE UNIVERSITY HOSPITAL SHOULDER SPLINT

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The modern conception of shoulder support after injury, bursitis or fracture in this region, is summed up in abduction and external rotation.

To accomplish abduction in the most direct and simplest manner is highly desirable. Plaster-of-Paris spica of the shoulder, triangle splints and aeroplane splints all have their advocates.

In Fig. 1, I wish to present a simple and easily made splint which accomplishes this object.

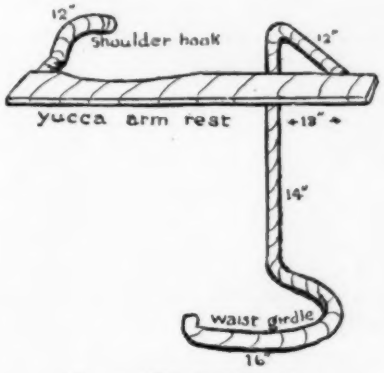


Fig. 1.—The shoulder splint.

It is constructed of a rod of iron ⅜ inch thick and six feet long. This is bent in a vise or wrenches first into a girdle 16 inches long to rest about the flank, either above or below the iliac crest; an upright section at right angles, 14 inches long; an arm projection 12 inches long, bent at a right angle in the plane of the girdle support; a forearm section, 18 inches in length, in the plane of the latter, bent at an acute flexion, and a hook over the opposite shoulder so adjusted that it rests over the trapezius, not on the scapula.

A thick yucca board, cut concave to fit the chest at its wrist segment, is strapped on the iron frame with adhesive. The girdle and shoulder hook are heavily padded. The whole splint is covered with cotton sheeting and gauze bandage. It is then ready to slip on the patient, where it should be adjusted to fit comfortably. It then stays in position without support. In the early stages of the immobilization it is advisable, however, to run a couple of laps of broad muslin bandage

beneath the girdle, over the opposite shoulder, where a generous pad should be placed, and also once or twice about the waist, as indicated by dotted lines in the picture. Also an adhesive strap may join the hook over the shoulder, across the back to the angle in the axilla. This gives increased stability.

Careful adjustment of all pressure points is necessary to avoid discomfort.

This splint is best applied over a thick undershirt. It is very light and can be made in twenty minutes. Where external rotation is necessary in addition to abduction, this splint will not serve. One made on the lines of a Cabot leg splint with its wide base resting on the flank or hip, its short arm against the body and its long arm extended in a position of extreme abduction, will answer the requirements perfectly.

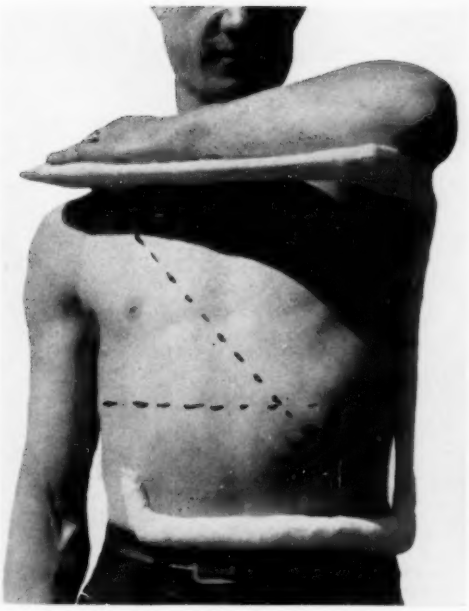

FIG. 2.—The shoulder splint applied.

# AN EVALUATION OF ASEPSIS AND ANTISEPSIS

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It would seem obvious that the greatest care should be exercised in the operating room looking toward the prevention of sepsis. Nevertheless, a hospital executive of wide experience recently expressed to the writer a doubt (shared by many), as to the necessity of all of the usual elaborate precautions. The investigation which led to the writing of this paper was undertaken for the purpose of learning, if possible, what is and what is not essential.

Under normal conditions the steam sterilizer is dependable. We are ordinarily assured of sterile draperies, gowns, dressings, instruments, and suture material. Catgut prepared by the operating room staff was at one time a menace, but the modern tube gut kept in a 1-500 mercuric chloride solution and placed in alcohol 95 per cent. shortly before use is safe. Catgut is not now the surgeon's alibi as formerly, nor is it fair for the operator to place upon the operating room nurses or assistants an onus which perhaps should attach to himself.

For example, preservation of the normal resistive and recuperative powers of the tissues is an important measure of prophylaxis against infection as emphasized by Whiting and Slocum.[1] To this end bleeding points in the incision should be clamped and immediately tied off. Clamps allowed to remain for a time produce necrosis and there is no assurance that hemorrhage has been permanently controlled. Devitalization of tissue and blood clots favor infection.

Many operators are heavy handed. They should cultivate gentleness. The incision must be ample to avoid pulling and hauling at its margins, and retractors should be placed carefully. The writer has never subscribed to the dictum that the hands had best be kept out of the incision. An unpunctured rubber glove is neither more nor less sterile than an instrument since both have been made aseptic by boiling, and the touch of rubber-encased fingers is surely less traumatizing than the harsher contact of metal. The deeper strata of the incision should be protected by walling off the skin edge with towels, as perfect asepsis of the skin is perhaps unattainable.

Indeed, the problem of skin disinfection is extremely serious, as illustrated by the following report: From a hospital doing excellent work in a large city comes the statement that during one week on the surgical and gynæcological services 22 operations were performed. Primary union occurred in but 13 cases. The remaining 9 patients all suffered from some form of sepsis, as a result of which 4 died. Twelve cases were operated upon in the orthopædic service during the same period without an infection. To this report is appended an explanatory note: "The occurrence of a high

percentage of post-operative sepsis as shown in these series of cases demanded investigation. Careful bacteriological studies were made of every possible source of infection. Bacteria were grown in several cases, but only from the field of operation before the incision was made. This indicated that the method of cleansing the skin of the patient for operation was at fault. McDonald's solution had been recently introduced in place of the tincture of iodine as a routine procedure, and was therefore given up when the report of the bacteriologist was that bacteria were found in cultures from the skin and that the solution itself has distinctly less penetrating power than the tincture of iodine.

"At the time of the operation it was stated that our use of McDonald's solution was tentative only. The objections to it, noted at that time, were that the coal-tar derivative employed was a proprietary preparation, the exact composition of which was not known, and that it was put on the market as a household and general disinfectant and bactericide, without guarantee as to strength or purity. These points in themselves should have been sufficient for its rejection, but we were influenced by the enthusiastic reports of others, and did not make bacteriological studies before adopting it. Attention is called to the difference between the results of the orthopædic and the other services as to sepsis. Practically the only difference in the technic was in the method of preparation of the field of operation, the tincture of iodine and not McDonald's solution being used in the orthopædic cases."

The difficulty of skin sterilization has long been recognized. Whiting,[2] who has investigated the subject at length, reminds us that the older surgeons scrubbed the skin industriously and long in the hope of securing surgical cleanliness, merely, as asepsis was considered unattainable. Whiting states that the methods of skin sterilization comprise (1) The wet method, which consists of mechanical scrubbing with green soap, shaving and the application of some antiseptic. Prolonged scrubbing with warm soap and water encourages the migration of bacteria to the surface where they can be removed, but it damages the skin and lowers resistance.

The antiseptics commonly used are alcohol, thymol, iodine, and the biniodide and bichloride of mercury. The latter has very little germicidal action in aqueous solutions as demonstarted by Post and Nicoll. "They are absolutely ineffective where prompt disinfection is required, as in the disinfection of the hands and fields of operation." Bichloride coagulates albumen and aqueous solutions cannot penetrate the deeper layers of the skin. Whiting believes that alcoholic solutions of bichloride are much more efficient, especially on a dry skin. Harrington's solution destroys germs in from thirty seconds to two minutes. It is irritating to the skin. Various observers disagree as to the germicidal power of alcohol in different strengths. It is widely lauded as a vehicle for other antiseptics because of its power of penetration. As a solvent or vehicle for the various antiseptics used on the skin, it is vastly superior to water, the alcoholic solutions pene-

trating more deeply and having greater germicidal power than the aqueous. Grossich, in 1908, recommended that after shaving the operative field iodine, 10 to 12 per cent. in alcohol, be applied to the dry skin. (2) The dry method of sterilization may be carried out as advised by Grossich, or the field may be rubbed with bichloride, 1-1000 in 70 per cent. alcohol solution. (3) The combined method consists in thorough washing and scrubbing and covering the field with a dry, sterile dressing as a preliminary, and an application of an antiseptic to the dry skin eight to ten hours later with a second application on the table.

Whiting believes that the forces of nature will sterilize the skin absolutely, although germicides will not, with certainty. He has observed that people who bathe frequently, or those who sweat profusely, are less liable to infection of wounds, the skin being washed from within outward.

In tests made by Whiting for skin sterility before neutralization of the antiseptic nearly all cultures were negative; after neutralization 60 per cent. showed growths. In about 85 tests made one-half hour after preparation by both wet and dry methods a growth was obtained in all except two instances, the bacteria being brought to the surface by the natural activity of the skin. In tests of the sterility of the hands the number of bacteria from the surface decreased with each operation, the hands being scrubbed and incased in rubber gloves between each two operations. After the seventh or eighth operation the surgeon's hands were sterile and remained so until contaminated from without. In another series of tests the skin was artificially sweated by a hot application of glycerine and kaoline for four twelve-hour intervals. All cultures were negative at the end of the forty-eight hours.

Serious investigation of the actual and relative value of antiseptics was first instituted, according to Post and Nicoll,[3] by Koch in 1881. The "thread method" of Koch consists in drying bacteria on threads and suspending them in the solution to be tested. Kronig and Paul, in 1897, devised the "garnet method" by which bacteria dried on garnets are immersed in various germicides. In 1903 Rideal and Walker described their "drop method" in which a certain quantity of broth culture of bacteria is added to a given amount of the solution to be tested. The method of procedure of Post and Nicoll is as follows: One-half c.c. of the solution to be tested is placed in a small test-tube. Into this solution is deposited one platinum loopful of an emulsion (in culture broth) of a twenty-four hour culture (on blood-agar slant) of the organism used. After various intervals a loopful of the contaminated test solution is thoroughly mixed into a tube of blood-agar and plated. Observations are made after incubations of twenty-four, forty-eight and seventy-two hours. Although clinical conditions are not simulated a most favorable opportunity for action is afforded, and from the uniformity of results conclusions may be drawn as to relative activity. Tests demonstrated the prompt action of green soap, alcohol above 50 per cent., silver nitrate as dilute as 1-1000, the iodine solutions, either as the

tincture or in aqueous solution with potassium iodide, and prenol 5 per cent. This investigation emphasized the unreliability of chemicals formerly supposed to be efficient, and the extremely slow action of mercuric chloride.

Bovee[4] concludes, as a result of numerous scraping cultures, that 5 per cent. tincture of iodine sterilizes the skin after a period of time from two minutes to fifteen minutes from its application. The inhibitive action of alcohol is great but is increased by the addition of iodine. After the application of three coats of iodine, two preceding and one following operation, and the part protected by a sterile dressing, Bovee has secured negative cultures from scrapings taken fifteen days after operation.

It occurred to Robb[5] that negative cultures obtained from skin still coated with iodine possibly would not prove that the solution was germicidal since even a small amount of that chemical in a culture medium might inhibit the growth of organisms. If bacteria live in spite of the iodine some are apt to be carried into the peritoneal cavity and there, freed of their iodine, go on to dangerous development.

In experiments conducted upon 21 patients when the iodine was present upon the skin 96.4 per cent. of cultures were sterile. After removal of the iodine 57.6 per cent. remained negative.

Further experiments were made with bacteria growing in vitro. Fifty per cent. iodine tincture, added to growing cultures, and allowed to remain during incubation stopped growth. When, in other experiments, the iodine was washed out in sterile water after acting for two minutes, abundant growths were obtained.

Robb concludes that there is still no certain method of sterilizing the skin, that tincture of iodine in all probability possesses a definite inhibitory action upon the growth of bacteria, and that sterilization with tincture of iodine is not to be relied upon, and should be used only when more elaborate forms of sterilization are contra-indicated.

Seelig and Gould[6] consider previous methods of testing germicides faulty as they were carried out under artificial conditions.

A germicidal solution cannot be thoroughly effectual unless it possesses the power of penetration in order to attack resistant bacteria in the deeper tissues. This power of penetration is the process known as osmosis.

Seelig and Gould tested the ability of various germicides, in watery solution, to pass through a colloidin membrane and destroy bacteria. Iodine alone possessed this property. The experiments with alcohol were surprising. Alcohol in the highest strengths penetrated to the bacteria and killed them very quickly, the greater the percentage strength the quicker the action. Experiments with alcoholic solutions of antiseptics demonstrated that, with the exception of iodine, the unadulterated alcohol acted as rapidly and efficiently as did the alcoholic solutions of germicides. Harrington's solution was no more efficient than its 60 per cent. alcohol content. An alcoholic solution of iodine killed the bacteria more quickly than did the highest strengths of alcohol alone.

Although these experiments were highly suggestive Seelig and Gould wished, if possible, to more closely simulate clinical conditions. They therefore utilized animal membranes. The method of procedure was as follows: A small salt-cellar was filled with the germicidal solution to be tested and then a flap of skin (still alive and attached to the animal) was laid over the salt-cellar in such a fashion as to pouch into the fluid. Into the pouch, which was bathed on one side (the outer surface of the skin) by the fluid to be tested, was put a measured quantity of a broth culture of bacteria. Live mesentery and live omentum were also used.

The results obtained were quite comparable to those secured in the experiments with the colloidin membrane. Alcohol penetrated and was effectual as a germicide in direct proportion to its percentage strength. It even penetrated the hide-like skin of the rabbit. Tincture of iodine penetrated and killed even more rapidly than did strong alcohol. Quite unexpectedly carbolic acid in 5 per cent. solution quickly penetrated an animal membrane although the same strength solution had failed to pass through colloidin. It should have been foreseen, however, in view of the fact that watery solutions of carbolic acid may readily be recovered in the urine after extensive skin applications of this drug.

" That washing the skin with water swells the epidermis, thus imprisoning the bacteria; or that the water softens the epidermis so that it desquamates and easily brushes off during operative manipulations, or that the excess of water dilutes the alcohol used subsequently," are reasons suggested to account for the fact that iodine and alcohol are most efficient on a dry skin. None of these, however, is correct, according to Seelig and Gould. Repeating the experiment of Lhermite[7] they found that by rubbing the rabbit's skin with castor oil the alcohol penetrated much more quickly. Seelig and Gould conclude that a preliminary washing of the skin, which removes its natural oiliness, decreases the osmotic power of iodine and alcohol, and that this alone is the reason for the use of these chemicals on the dry skin.

Keilty and Packer[8] conducted a series of laboratory tests for the purpose of determining the relative inhibitory and germicidal power and diffusibility of various antiseptics, and their most effective strength. The phenol group and thymol gave the best results although tincture of iodine 3 to 10 per cent. and mercuric iodide 10 to 30 per cent. were markedly active. Alcohol seemed inert. Keilty and Packer state that their results are merely experimental and must be borne out by clinical application. They note the possibility of toxic effects from the phenols.

Whiting and Slocum believe that perfect asepsis of the skin is not essential to primary union, and that conservation of the natural resistive and recuperative powers of the tissues is an important measure of prophylaxis of wound infection. Laboratory and clinical findings should be correlated. The germicidal power of various antiseptics should be compared with carbolic acid or phenol as a standard according to the Rideal-Walker coefficiency test. Scrapings from the skin are imbedded in culture media and incubated.

Whiting and Slocum investigated various so-called phenols (coal-tar disinfectants) of high coefficiency but less corrosive and less poisonous than carbolic acid.

In their clinical tests the operative field was wet-shaved and the patient was given a warm tub bath the night before operation. On the day of operation without further preparation, scrapings from the skin were taken and cultured. All showed growth of staphylococci. The part was rubbed for two minutes with guaze saturated with the solution to be tested. The solution was washed off with sterile water or allowed to evaporate. Cultures made from scrapings were all sterile. Out of 446 tests made one half hour later, to show whether or not bacteria had been brought from the deeper layers of the skin, contamination occurred in 37 instances and a growth of staphylococci appeared in one tube. Cultures from strips of skin showed numerous growths, due chiefly to contaminations by non-pathogenic bacteria.

Laboratory tests convinced Whiting and Slocum that acetone has no germicidal power. Alcohol, in strengths varying from 40 to 50 per cent. destroyed the bacillus typhosus in less than two and one-half minutes. Acetone 40 parts, and alcohol 60 parts, also destroyed the bacillus typhosus in less than two and one-half minutes. Acetone 40 parts, alcohol 60, and liq. cresolis comp. 2 parts gave the same results. Various other coal-tar products with acetone, and alcohol in strengths varying from 60 to 65 per cent. all destroyed the bacillus typhosus in less than two and one-half minutes. None of the proprietary preparations possessed as high a phenol coefficient as was claimed by the manufacturer.

Whiting and Slocum conclude that none of the various solutions used will destroy all germs of the skin in all instances, but that a solution consisting of acetone, alcohol and one of the coal-tar disinfectants of a high phenol coefficient is more efficient than any other agent we have ever used for skin sterilization. The acetone is solvent of the fats and oils. The alcohol is solvent and germicidal. The acetone and alcohol prepare the way for the powerful germicidal action of the coal-tar disinfectant.

In regard to the clinical use, which might, perhaps, be termed "test" of iodine, much could be said. Robb states that Grossich[9] has an undoubted claim to priority in advising its use on the dry skin, although Major Woodbury, U. S. A.,[10] had utilized the tincture of iodine for skin preparation in 1906. Wollheim,[11] also, has found evidence in the literature that Cannaday, in 1906, and Dannreuther, in 1908, had made use of it upon the skin previous to the paper of Grossich.

Stretton[12] voices his supreme confidence in the efficacy of iodine with the statement that its use has been satisfactory to him in over 3000 cases, without preliminary scrub, no matter how dirty the skin may appear, nor shave, except the hair be very long. He makes an application of two and one-half per cent. tincture of iodine B. P. and two and one-half per cent. potassium iodide one-half hour before operation, another on the table, and a third over the incision after sewing up.

Lambert[13] conducted a series of experiments to determine the comparative effects of various antiseptics upon human tissue cells growing in vitro, and upon bacteria.

"In the case of the majority of the chemicals used (potassium cyanide, phenol, tricresol, hydrogen dioxide, and alcohol) tissue cells were definitely more easily killed than were bacteria.

"Iodine stands out as the one chemical treated to which cells were found to be more resistant than were staphylococci. A growth of cells were seen after exposure to a 1-2000 solution of iodine for one hour, a strength sufficient to sterilize the tissue completely in most instances.

"These experiments afford further experimental evidence of the value of iodine as an antiseptic, and indicate that, at least in weak aqueous solution, it should not, as is often stated, injure or irritate the tissues. It was observed, however, that iodine has the property of rapidly dissolving fibrin, a property which, theoretically, should not be conductive to wound healing. A similar action by hypochlorites (Dakin's solution) was also noted."

(During a visit to the Mayo clinic in 1914 the writer saw Dr. Judd swab the walls of the incision with iodine after removing a malignant tumor from the bladder. Judd stated that this practice had not seemed to interfere with union.)

Lambert concludes that "The comparative resistance of bacteria and human tissue cells to antiseptics and other chemicals may be easily tested by tissue cultures under conditions which approximate those found in the living body.

"A comparative study shows that while human cells (connective tissue and wandering cells) are highly resistant to many antiseptics, they are in general more easily killed than bacteria (staphylococci aureus).

"Of the antiseptics tested, which include mercuric chloride, iodine, potassium mercuric iodide, phenol, tricresol, hydrogen peroxide, hypochlorides (Dakin's solution), argyrol, and alcohol, the one which approaches most closely the ideal disinfectant is iodine, which kills bacteria in strengths that do not seriously injure connective tissue cells or wandering cells."

In the prophylaxis of infection we must consider, according to Bond,[14] the inhibitory action of strong antiseptics upon the normal activity of the phagocytes.

Bond learned that a cotton thread boiled in water containing powdered indigo in suspension laid in aseptic wounds untreated with strong antiseptics was almost decolorized in forty-eight hours. In wounds treated with strong antiseptics, mercuric chloride 1-1000, or carbolic acid 1-20, the thread showed some delay in decolorization. Control experiments with salt solutions gave normal reactions.

Investigation has convinced Bond that "The fact that phagocytes are constantly transporting organisms from the cavity or the surface to the tissues which form the walls of a wound means that any adverse influence acting on these loaded cells on their return journey calculated to interfere

with their power of retaining and digesting these ingested organisms is a source of danger. It is possibly in this way that antiseptic solutions act prejudicially when used too continuously or in a too concentrated form." That there is a return emigration of wandering cells from a wound is demonstrated by Bond by powdering granulations with indigo and finding, on section, evidences of pigment remote from the surface.

In a series of 10 cases the writer has made investigation of the scalpel with which the skin incision was made, by means of stab cultures. There were no growths of pus-producing bacteria although several contaminations occurred. These tests prove nothing as regards skin sterility but are at least suggestive that the use of two scalpels in making the incision is probably unnecessary.

Concerning the use of rubber gloves Morris[15] considers that rapid operating through small incisions by sense of touch without gloves is essential in emergency surgery such as operations for perforated gastric, duodenal, or typhoid ulcer, or in dissecting out firmly adherent structures as a pyosalpinx or an appendix. Morris believes that large incisions and tedious technic allow bacteria to enter the wound from the air. Men who wear gloves are apt to be careless in the preparation of their hands. From personal observation Morris states that he has no more infection from operating with bare hands than do other surgeons who wear gloves while operating in the same hospital. Those who habitually use thick gloves never develop that finer sense of touch which the older generation of surgeons possesses. He concludes, however, that the modern thin glove is less objectionable.

Jonas[16] quotes O. Wandel and O. Hoehne to the effect that rubber gloves smeared with cultures of streptococci and staphylococci, or with pus of the same origin and allowed to dry for twenty-four hours, could, in many instances, be sterilized by a vigorous scrubbing with green soap and water for two and one-half minutes.

Brewer,[17] who has made numerous studies of aseptic technic, notes that infections prolong the hospital stay, work hardship upon the patient, and increase the hospital burden.

He traces the decrease in wound infections in the City Hospital from 39 per cent. in 1895, to 3.2 per cent. in 1900. This improvement was brought about by the installation and intelligent use of adequate sterilizing apparatus, many changes in technic, the use of a dilute solution of formaldehyde for wound disinfection and dressings, and the employment of sterile rubber gloves. The only accurate gauge of the number of infections, and hence the opportunity of improving individual aseptic technic, is dependent upon careful records of infections. Brewer states that the air of the operating room was constantly contaminated by pus-producing germs, as demonstrated by agar cultures. It became necessary to cover the instruments, etc., with sterile coverings and to irrigate the wounds. This state of affairs does not exist, of course, in hospitals treating patients from the higher walks of life whose living conditions are better.

Brewer relates that early in his service at the Roosevelt Hospital an epidemic of infection occurred. There were five cases in one day and several on the succeeding few days. Cultures were taken from gloves, gowns, caps, towels, sheets, sponges, instruments, ligature and suture material. The latter showed growth, and when the stock of contaminated gut was destroyed the epidemic of infection ended. Two cases of infection with the bacillus aërogenes capsulatus occurred within a few days. The source of the bacilli was not found but the investigation revealed a defect in the steam sterilizers.

Brewer inaugurated a weekly report of each patient operated upon and every infection was investigated. During the first six months of 1912, six out of two hundred and fifty clean cases became infected, a percentage of 2.4 per cent. Not being satisfied with this result the staff surgeons censored each other's operations, carefully observing details. This investigation showed "That the suture and reserve instrument tables were too near the operating table, and that the towels covering these were not infrequently contaminated by orderlies and instrument nurses while bringing in the patient, handling hand lights, or the cautery apparatus." Other possible errors in technic were noted resulting in a rearrangement of the operating room furniture, having the patient placed upon the operating table, prepared and draped in another room, and other changes. The report for the ensuing six months revealed only 1.2 per cent. of infection in 234 clean cases. The adoption of long sleeved gowns seems to have been an improvement. Investigation showed that three cases which developed infections near together were operated upon under local anæsthesia. The novocaine solution, which had been prepared in the drug department, was found to be contaminated.

*Summary.*—Analysis of the several investigations herein quoted is extremely instructive. For example:

Whiting and Slocum state that alcohol, 40 to 95 per cent., will kill the bacillus typhosus in practically the same time as various coal-tar derivatives in alcoholic solutions of from 60 to 65 per cent. Nevertheless, they consider the phenols to be more efficient germicides.

Post and Nicoll learned that mercuric chloride has very little germicidal action in aqueous solutions.

Whiting believes that alcoholic solutions of mercuric chloride are much more efficient, especially on dry skin.

Grossich emphasizes the importance of using alcoholic solutions of iodine on a dry skin.

Of alcohol Whiting says: "As a solvent or vehicle for the various antiseptics used on the skin, it is vastly superior to water, the alcoholic solutions penetrating more deeply and having greater germicidal power than the aqueous."

Keilty and Packer conclude that alcohol is practically inactive as a germicide.

Post and Nicoll rank alcohol, in solutions of more than 50 per cent., as one of the most active germicides.

Comment: Some investigators have underestimated the germicidal power of alcohol.

Bovee's tests of the skin, leaving the iodine on, gave negative cultures fifteen days after operation.

Robb believes that the action of iodine is merely inhibitory and he fears peritoneal invasion by unkilled germs during operation.

Robb and Whiting both obtained sterile cultures before neutralization of the antiseptic but a large percentage of growths occurred after neutralization.

Post and Nicoll also consider tests of doubtful value unless the action of the antiseptic is stopped forthwith.

Comment: Clinically, iodine is allowed to remain upon the skin. It penetrates into the deeper layers, and we have no means of determining how long its activity may continue. The consensus of opinion classes iodine as an effective germicide. Granting that its action may be delayed, or that perfect asepsis of the skin is unattainable, or assuming, with Robb, that iodine merely inhibits germ life, nevertheless, the tissues, including the peritoneum, can defend themselves against limited numbers of bacteria.

Morris enumerates the disadvantages of rubber gloves.

Comment: The fact that hand sterilization is so difficult and glove sterilization so easy would seem to outweigh the objections to the use of the latter.

Seelig and Gould are convinced that laboratory tests which do not simulate clinical conditions are of little value; that alcohol in solutions of 50 per cent. or more is strongly germicidal but less so than iodine; that a solution of alcohol and iodine together is more germicidal than either alone; that alcohol, carbolic acid, and iodine can penetrate animal membranes, and that penetration is facilitated by the presence of oil in the skin.

Lambert has shown that iodine, alone, of various tested antiseptics, will kill bacteria rather than tissue cells.

Comment: Although the phenols have decided germicidal powers, and possess the ability of penetrating animal membranes, they are, unfortunately, tissue destroyers. Clinically, alcohol is non-irritating.

Brewer demonstrated that infection may be due to minor lapses in technic, to germ-bearing suture material, to contaminated novocaine solution, or to failure of the steam sterilizer.

Comment: It is not safe to assume that any link in the chain of technic is unbreakable.

## CONCLUSIONS

1. Abundant clinical evidence of the efficacy of iodine in skin sterilization has been corroborated by laboratory findings.

2. The germicidal action of mercuric chloride is too slow to be of value in sterilization of the skin.

3. Eternal vigilance is the price of asepsis.

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# TRANSACTIONS
OF THE
# NEW YORK SURGICAL SOCIETY

*Stated Meeting, held April 25, 1917*

The President, Dr. Charles N. Dowd, in the chair

## CARCINOMA OF RECTUM: ABDOMINOSACRAL OPERATION

Dr. Franz Torek said that, as there had been shown before this Society, on previous occasions, a number of cases of combined abdominosacral operations with the establishment of an artificial anus, he wanted to present a case in which the lower end of the sigmoid was implanted in the anus, not in the abdomen, thus giving the patient a natural, instead of a preternatural, anus.

The patient was a woman, about forty-three years old, who had come under his observation suffering from pain in the rectum, constipation, and pain radiating down on the posterior surface of the left thigh. Rectal examination revealed the presence of a crater-shaped ulcer with thick edges, about 1½ inches in diameter, situated on the left wall of the rectum, about ¾ inch above the upper edge of the sphincter, or about 2 inches above the anus.

On November 15, 1916, an amputation of the rectum by the combined abdominosacral route was performed. The first step was the exploration. A median incision was made from the pubes upward, and the patient was placed in Trendelenburg's posture. The tumor of the rectum was felt in the location described before. It did not seem to infiltrate the surrounding tissues, but there were numerous para- and post-rectal enlarged lymphatic nodes. There were no metastases found in the liver nor in other parts of the abdomen.

The next thing was the mobilization of the sigmoid, which in the operation he was describing formed the most important step. In those methods of operating in which the sigmoid is implanted abdominally, a special technic of mobilization is not essential; but in this operation the correct mobilization of the sigmoid, performed in such manner as not to endanger its blood supply, is really the main thing of the whole operation, being often of vital significance.

As a rule, the lower part of the sigmoid flexure is suspended from the inferior mesenteric artery and its prolongation, the superior hemorrhoidal artery, in such manner that it cannot be drawn down to the anus unless that blood channel is divided in some part of its course. It was divided in the course of the inferior mesenteric artery, some distance above the point

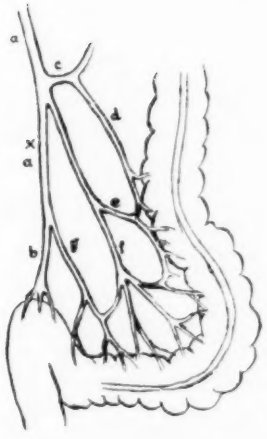


FIG. 1.—Schematic drawing of the blood supply of the lower colon. *a*, inferior mesenteric artery; *b*, its terminal branch, or continuation, the superior hemorrhoidal artery; *c*, left colic artery; *d*, its descending branch; *e*, *f*, *g*, the first, second, and third sigmoid arteries; x, point where the inferior mesenteric artery is to be divided. This diagram shows the lower sigmoid to be suspended from the inferior mesenteric and superior hemorrhoidal arteries in such manner that it could not be brought down to the anus without division of this suspending cord in some part of its course. It also shows that, while the sigmoid arteries, *e*, *f*, *g*, anastomose freely among themselves and upward, there is no collateral circulation between the lowest sigmoid artery, *g*, and the superior hemorrhoidal artery, *b*. Therefore, the site for dividing the inferior mesenteric-superior hemorrhoidal blood channel is not in the superior hemorrhoidal section of it, as, owing to the absence of collateral circulation from the lowest sigmoid artery, the part supplied by the superior hemorrhoidal would be insufficiently nourished and hence would probably undergo necrosis. The proper place at which to divide the vessel is in the inferior mesenteric artery, a little above the place where the lowest sigmoid artery is given off. Then the blood from the upper sigmoid arteries can pass up through the lowest sigmoid, *g*, and down again through the superior hemorrhoidal artery, *b*.

where the lowest sigmoid artery is given off. The selection of this point for division of the vessel is of the greatest importance, as the maintenance of an uninterrupted communication between the lowest sigmoid artery and the superior hemorrhoidal artery is absolutely essential for the establishment of collateral circulation between the upper sigmoid vessels and the superior hemorrhoidal artery, as the branches of the latter vessel are, in the true sense, terminal arteries, and its ramifications have no collateral circulation. If, on the other hand, the mobilization were accomplished by dividing the vessel below the origin of the last sigmoid artery, the lower sigmoid and pelvic colon would have their blood supply shut off (compare Fig. 1).

To find the inferior mesenteric-superior hemorrhoidal trunk—it is in reality one trunk, simply changing its name where the lower sigmoid is given off—the sigmoid flexure is drawn to the left and slightly downward. Then, as a rule, the mesosigmoid will give everywhere except where the above-named channel runs through, and, in consequence, that part of the mesosigmoid will become tense and will stand out in the form of a fold of peritoneum extending to the promontory of the sacrum.

The point of origin of the lowest sigmoid artery was called by Sudeck the "critical point" in his description of the blood supply of the rectum in its bearing on operative surgery. This point lies 1 or 2 cm. below the insertion of the peritoneal fold, just described, at the promontory. The artery, if found, is tied about 2 cm. above the promontory. Its accompanying vein can usually be readily recognized by its blue color. If it cannot be recognized, the mesosigmoid is tied above the promontory, at the height of the fifth lumbar vertebra, and divided. In the further course of the mobilization one should keep as far away from the gut as possible.

From the point of ligation the two layers of the peritoneum forming the mesosigmoid were cut downward in a direction parallel to the pelvic colon, on either side of which and of the rectum the incisions extended down to Douglas' pouch, where they were united by a curved incision anterior to the rectum. The limbs of the sigmoid flexure were unfolded by radiary incisions of the mesosigmoid, care being taken not to injure the marginal arcades.

Now the pelvic colon and rectum were freed by blunt dissection with the hand, starting at the point of ligature and incision of the mesosigmoid, keeping close to the surface of the promontory, as far away from the intestine as possible, into the depth of the small pelvis. Thus the whole pelvic mesocolon with its glands remained in connection with the gut. This procedure was bloodless. Some arteries, probably the medial and lateral sacral, were tied before being divided. The separation of the rectum from the uterus was not difficult. Then the lateral strands were divided. In this manner the rectum was liberated down to the levator ani. The loosened intestine was now pushed well down into the pelvis, and the two edges of the divided mesosigmoid and of the peritoneum farther down were

sutured to the upper sigmoid in its new, lower position. The abdomen was now closed.

The patient then was placed in the right Sims position. The buttocks and the anal, coccygeal, and sacral regions were sterilized. An incision from the posterior margin of the anus to the lower part of the sacrum was made. The coccyx was freed from the soft parts covering it and resected.

The rectum in its lower part was now separated bluntly from the vagina and the adjacent areolar tissue. A large loop of gut, consisting of rectum, pelvic colon, and part of the sigmoid, could now be pulled out of the wound. A piece of gauze was passed under it, and with the use of traction on the lowest part of the rectum this was separated from the sphincter muscle, the dissection being partly blunt, partly sharp, so that now the rectum was attached below only at the mucocutaneous border of the anus.

The anus was now stretched wide by an assistant, whereupon the rectum was pushed out through the anus, and the tumor with it, by a process of invagination. Up to this point the operation was an entirely aseptic one. The wound above the anus was now protected by gauze, and the operation proceeded with from the anal end.

The tumor now protruded outside of the anus, being situated at the apex of a double tube, the outer layer of which was the anal portion of the rectum turned inside out, *i.e.*, its mucous surface on the outside. This outer tube was now cut close to the mucocutaneous junction, leaving a cuff less than half an inch long. Now the inner tube could be drawn out further, to any desired point. At 2½ inches above the tumor a silk ligature was tied around the gut. This was amputated below the ligature and the end cauterized with a Paquelin.

Gloves were now changed. At a distance of three-fourths inch above the cut end the gut was sutured to the anal cuff with interrupted silk sutures. The silk ligature around the gut was now cut. The attachment of the gut to the anal margin so as to let it protrude a short distance was chosen in order to allow for a certain amount of subsequent retraction. The further course, however, showed that such retraction did not occur. The sacral cavity was packed with iodoform gauze, and the wound was partly closed.

The duration of the operation was two hours and five minutes, in the course of which an intravenous infusion of 600 c.c. with 15 minims of adrenalin was given.

The patient was kept constipated for six days, during which time she felt quite uncomfortable. Then an ounce of castor oil was administered, after which her condition was satisfactory.

Twenty days after the operation the small protruding end of gut was cut off and the freshened end sutured to the skin.

The patient ran a normal, afebrile course throughout and was discharged from the hospital on December 16, four weeks and three days after the operation.

FIG. 2.—This fails to represent the real size of the prolapse, as it was taken with the patient lying down, in which position nearly half of it slipped back.

She has a normally functionating sphincter and has one movement a day, usually after an enema. Just above the anal margin, corresponding to the union of gut and skin, there is a stricture which is now being dilated.

The pathological diagnosis was: Carcinoma of the rectum with metastases in the lymph-nodes.

DR. HOWARD LILIENTHAL said that about ten days ago he operated for the extirpation of a constricting carcinoma of the rectosigmoid. After mobilizing the sigmoid and upper rectum through a left paramedian incision, a minute puncture in the sigmoid about six inches above the growth was made, and through this puncture the blunt end of a large probe was inserted and pushed on until it appeared at the anus. Through the eye of the probe, still within the abdomen, there was threaded a piece of tape, and this tape was tied firmly around the mobilized sigmoid. An assistant now withdrew the probe from the anus until the tape could be grasped, and then on firm traction an anal prolapse of the rectosigmoid was produced, bearing with it the carcinoma. The patient was now placed in the lithotomy position and the tumor-bearing gut was resected, anastomosis with two layers of sutures was effected and the parts returned to the abdomen by pushing them back through the anus. The abdominal wound was closed by suture with gauze and rubber dam drainage.

The packing was removed to-day and there has not been a single drop of leakage.

NOTE.—At the present editing, four weeks after this operation, the patient is entirely well and has been discharged from the hospital.

DR. WM. T. LUSK said that he had found that there often was a good sized artery running alongside the terminal portion of the sigmoid flexure, which joined the superior hemorrhoidal and sigmoid circulations, giving ample blood supply at this situation. However, Archibald of Montreal had injected these two circulations separately and demonstrated an area of poor vascularization where they met.

## PROLAPSE OF RECTUM OF EXCEPTIONAL SIZE: ABDOMINAL OPERATION AND SPHINCTER PLASTIC

DR. TOREK presented a man forty-eight years of age. He said that the photograph of the case (Fig. 2) did not really represent the correct size of the prolapse, as the picture, contrary to instructions, was taken in the recumbent position in which the protrusion was nearly half reduced.

The patient was admitted to the German Hospital on March 28, 1916. Forty years ago he had been operated for an abscess of the hip-joint, after which operation a number of fistulæ persisted. Two years later he was operated for a rectal fistula. Afterwards it was found that the fistulæ of the hip and the rectal fistula communicated. About this time his thigh was amputated at the hip-joint, but in spite of this a number of sinuses persisted, requiring fifteen more operations. Following the last operation on the hip the rectal fistula recurred, and an operation extensively dividing the

sphincter was done, which resulted, four years ago, in the production of a prolapse of the rectum, which gradually increased in size up to more than six inches in length.

On admission to the hospital the condition was one of a highly congested prolapse of the rectum over six inches in length, which was described by the house surgeon as having the shape of a large sized banana. Besides being intensely red it also presented some superficial abrasions and bled very easily on handling it. It was reducible only in the recumbent posture, but did not remain reduced even in that position; it would at once protrude again a little more than half the original volume, about to the extent shown in the photograph. The patient, who now looks the picture of health, was quite anæmic at that time, which was a little over a year ago, doubtless owing to the loss of small amounts of blood continued over a long period of time.

The anal opening was very large, consisting almost entirely of scar tissue. Only at one point, covering less than one-eighth of the circumference of the anal opening, could the remnants of the sphincter with its covering of wrinkled skin be seen.

The patient was kept in bed for two weeks preceding the operation in order to reduce as much as possible the congestion of the prolapsed part. On April 11, 1916, the abdominal part of the operation was performed—median incision from pubes almost to umbilicus, Trendelenburg's posture. The rectum was seen to have developed a very long mesorectum. This was incised on both sides and greatly shortened by suturing it over and on to the rectum after this had been drawn up to the utmost extent. The mesentery thus supported the rectum in its new higher position. The rectum was thus entirely covered by this additional layer of peritoneum. The pelvic colon was then sutured to the lateral abdominal wall with many silk sutures passed through peritoneum and fascia. The rectovesical pouch was obliterated by means of circular silk sutures. The appendix was found to be thickened and was removed with inversion of the stump.

Four weeks later, on May 9, the sphincter plastic was performed. The scar tissue was excised and the ends of the sphincter laid bare and sutured. This was not a very easy procedure. It did not heal by first intention, but the result, nevertheless, was such as to produce a satisfactory sphincteric action, and, in the year's time that has elapsed since the operation, the prolapse has not returned.

## THE TREATMENT OF STAPHYLOCOCCUS SEPTICÆMIA BY TRANSFUSION OF IMMUNE BLOOD

Dr. Ransom S. Hooker read a paper with the above title, for which see page 513.

## PLASTIC FLAP FROM ABDOMEN FOR BURN OF HAND

Dr. Clarence A. McWilliams presented a man of twenty-one years of age who was admitted August 4, 1916, for cicatricial contractures of

FIG. 3.—Case II.

FIG. 4.—Case II.

FIG. 5.—Case II.

FIG. 6.—Case II.

FIG. 7.—Case II.

FIG. 8.—Case II.

FIG. 9.—Case II.

back of hands and wrists. Eight months previously he had been severely burned in an explosion in a sugar factory. Was in a hospital for four months, where apparently no effort was made to skingraft his hands, resulting in thick keloid scars on the backs of both hands, the right being much the worse (Fig. 3). The palms were not affected, but the scar in the right involved the bases of all the fingers, the entire back of the hand and wrist and the anterior aspect of the wrist for three inches. The fingers could be flexed only one quarter the normal extent. The three innermost fingers were bent backward at the metacarpophalangeal articulation. The scars reach to the second phalangeal joints. It was decided to replace this scar tissue by skin taken from the abdomen pedunculated. The first operation was performed August 4, 1916 (Figs. 4 and 5). The entire scar from back of hand and wrist and from the front of the wrist was excised *in toto*, a tourniquet being applied about arm. It was a quarter of an inch thick and was peeled off the tendons in the back of the hand without opening the tendon sheaths to any extent. The fingers could then be easily flexed. The hand was laid on the abdomen (Figs. 4 and 5) above the navel. A vertical incision was made to the right of the navel and carried down to the muscle through the fat about five inches long. The fat was separated from the muscles the whole vertical extent of this flap and sufficiently far over to the left to cover the whole raw area. Were he to do this operation over again, he should not leave such a thickness of fat on the flap since the final result shows that the flap is too thick. The hand was inserted beneath this flap and small incisions were made through the flap corresponding to the positions where the finger bases would come through. The fingers were drawn through these openings, there being left a bridge of healthy, undivided skin between each finger. The entire raw surface edges were united with interrupted finest silkworm-gut sutures. Two goitre rubber drainage tubes were inserted above and below the wrist at point of union to evacuate the oozed blood. The arm was bound to the chest with plaster-of-Paris splint which was removed in three days and the arm held to the side (Fig. 4) with adhesive plaster. The wounds remained clean, though there was considerable bloody discharge from the angles. The second operation was performed on the fifteenth day after the primary operation. It was decided not to divide at this time the lower pedicle but to cover in the raw area on the front of the wrist by turning the hand over on this pedicle and reflecting over on to the raw area on the front of the wrist (the palm being uninvolved) a continuation upwards of the skin flap from the chest (Figs. 6 and 7). The flap from above was marked out one-third larger than the area to be covered and it was freed. The hand was then turned over and the flap was fitted into the raw area on the front of the wrist where it was sewn on the sides. The flap bled very freely, showing its blood supply to be ample. Prior to turning the hand, however, the undivided bridges of skin between the fingers had to be divided and the edges were sutured. The upper part of the defect on the chest was

extensively undermined and brought together with silkworm-gut, and Thiersch grafts were taken from the thigh to cover the remainder of the wound. These were covered by rubber mesh which he has found to be the best dressing for skin grafts.

The wound remained clean. The third operation, consisting in the division of half the transverse diameter of the lower pedicle, was performed on the twenty-first day after the first operation and six days after the second operation and the final division of the pedicle or fourth operation was made on the twenty-eighth day after the first operation and on the seventh day after the third operation. The blood supply of the flap was very profuse, the oozing being very free. The remaining raw area on the abdomen was covered with Thiersch grafts and several of these grafts were put in to cover small areas in some of the finger-webs.

The final result is shown in Figs. 8 and 9. The finger flexion has become perfect. There was no necrosis of any of the flap. Sensation has returned in the flap to about one-quarter of its extent.

## RESECTION OF FEMORAL VEIN FOR THROMBOPHILIA

Dr. Willy Meyer said that it seemed to him necessary, first to give an explanation regarding the wording of the title of this presentation. Personally he believed the disease which Dr. Buerger of New York termed thrombo-angiitis obliterans to be not one of the blood-vessels but of the blood itself. He therefore had called it " thrombophilia," in contradistinction to hæmophilia. He is of the opinion that the trouble is likely dependent upon a disease of the glands of internal secretion. What Dr. Buerger had explained as inflammation of the blood-vessel wall he considered to be not the primary but the secondary phenomenon.

Thrombophilia is a very mysterious disease. Not much is known about it. It occurs almost exclusively in men. Hæmophilia also occurs almost exclusively in men. Should the cause of the disease be found, conservative surgery would be feasible and the multiple amputations for gangrenous portions of the extremities, due to this cause, be avoided. So far quite a number of conservative methods of treatment have been tried, but none has given permanent satisfaction.

Of late the speaker had tried ligation of the femoral vein in seven patients. In two of these the vein was resected for the sake of immediate microscopic examination of a fresh specimen by the pathologist. One of these two patients is present. He is 34 years old and came to the hospital in a carriage; he couldn't walk more than one block. He had great pain. There was no pulse in either of the tibial arteries. The operation was somewhat complicated on account of the many branches that enter the femoral vein in just this particular region. Quite some hemorrhage was encountered; at last the proximal end of the vessel had to be tied just below Poupart's ligament. The wound healed kindly. To-day, four months after the operation, the patient is much improved; is able to walk eight to ten blocks, has much less pain, can sleep in bed.

The operation is done with the intention of retaining more blood in the extremity and to let the tissues have the benefit of this greater quantity of blood as long as possible. The explanation of the effect of the operation is simple in comparing the lower extremity with a washbasin which has a small influx and a wide outflow. In letting the water run in, the basin will be continually empty. If we now decrease the size of the outflow and have the same amount of water running in, it will soon begin to fill.

There are three places in Scarpa's triangle where the vein can be tied: at the top of the triangle, above the entrance of the deep femoral vein, and above the entrance of the saphenous vein.

Dr. Meyer prefers to tie the vessel at the base of the triangle, right below Poupart's ligament. The blood has then to return through the posterior (principally gluteal) veins and the internal iliac vein, and must of necessity have the greatest impediment to return.

The operation is never to be done in the presence of gangrene, as conditions get worse after it.

It seems that the operation is deserving of further trial.

He had under observation one patient who illustrates the late result of an arteriovenous anastomosis done for thrombophilia four years ago. He appears in perfect health to-day, although his original trouble is not cured. It is to be regretted that the patient is out of town. In the future more will be heard of arteriovenous anastomosis for the symptomatic treatment of this trouble.

## OLD DEPRESSED FRACTURE OF THE SKULL; JACKSONIAN EPILEPSY; BRAIN CYST; CRANIOTOMY WITH FAT TRANSPLANTATION

Dr. Meyer presented a lad, eighteen years old, who was hit, when in his seventh year, by a man whom he was watching split wood with an axe. He sustained a compound depressed fracture of the left parietal bone with great injury of the brain. He was brought to a nearby hospital, where he stayed for a few months, his wound healing slowly.

He slowly developed spasmodic contraction of the right hand and also partially of the toes of the right foot, and in the last months before his admission to the German Hospital, Jacksonian epilepsy. The question was whether one could possibly help such a patient with a surgical interference so many years after the injury. At the operation the scars were excised and the depressed bone exposed; a few holes were bored into the skull and cut through with a Gigli saw. A part of the bone was then carefully removed. When lifting out the bone a large amount of clear fluid suddenly escaped. A brain cyst had been opened, the wall of which was partially formed by portions of the formerly torn dura mater. Excision of this wall was done and the adhesions of dura and skull all around thoroughly loosened with the finger.

In order to provide against reformation of adhesions of the brain to

extensively undermined and brought together with silkworm-gut, and Thiersch grafts were taken from the thigh to cover the remainder of the wound. These were covered by rubber mesh which he has found to be the best dressing for skin grafts.

The wound remained clean. The third operation, consisting in the division of half the transverse diameter of the lower pedicle, was performed on the twenty-first day after the first operation and six days after the second operation and the final division of the pedicle or fourth operation was made on the twenty-eighth day after the first operation and on the seventh day after the third operation. The blood supply of the flap was very profuse, the oozing being very free. The remaining raw area on the abdomen was covered with Thiersch grafts and several of these grafts were put in to cover small areas in some of the finger-webs.

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## RESECTION OF FEMORAL VEIN FOR THROMBOPHILIA

Dr. Willy Meyer said that it seemed to him necessary, first to give an explanation regarding the wording of the title of this presentation. Personally he believed the disease which Dr. Buerger of New York termed thrombo-angiitis obliterans to be not one of the blood-vessels but of the blood itself. He therefore had called it " thrombophilia," in contradistinction to hæmophilia. He is of the opinion that the trouble is likely dependent upon a disease of the glands of internal secretion. What Dr. Buerger had explained as inflammation of the blood-vessel wall he considered to be not the primary but the secondary phenomenon.

Thrombophilia is a very mysterious disease. Not much is known about it. It occurs almost exclusively in men. Hæmophilia also occurs almost exclusively in men. Should the cause of the disease be found, conservative surgery would be feasible and the multiple amputations for gangrenous portions of the extremities, due to this cause, be avoided. So far quite a number of conservative methods of treatment have been tried, but none has given permanent satisfaction.

Of late the speaker had tried ligation of the femoral vein in seven patients. In two of these the vein was resected for the sake of immediate microscopic examination of a fresh specimen by the pathologist. One of these two patients is present. He is 34 years old and came to the hospital in a carriage; he couldn't walk more than one block. He had great pain. There was no pulse in either of the tibial arteries. The operation was somewhat complicated on account of the many branches that enter the femoral vein in just this particular region. Quite some hemorrhage was encountered; at last the proximal end of the vessel had to be tied just below Poupart's ligament. The wound healed kindly. To-day, four months after the operation, the patient is much improved; is able to walk eight to ten blocks, has much less pain, can sleep in bed.

The operation is done with the intention of retaining more blood in the extremity and to let the tissues have the benefit of this greater quantity of blood as long as possible. The explanation of the effect of the operation is simple in comparing the lower extremity with a washbasin which has a small influx and a wide outflow. In letting the water run in, the basin will be continually empty. If we now decrease the size of the outflow and have the same amount of water running in, it will soon begin to fill.

There are three places in Scarpa's triangle where the vein can be tied: at the top of the triangle, above the entrance of the deep femoral vein, and above the entrance of the saphenous vein.

Dr. Meyer prefers to tie the vessel at the base of the triangle, right below Poupart's ligament. The blood has then to return through the posterior (principally gluteal) veins and the internal iliac vein, and must of necessity have the greatest impediment to return.

The operation is never to be done in the presence of gangrene, as conditions get worse after it.

It seems that the operation is deserving of further trial.

He had under observation one patient who illustrates the late result of an arteriovenous anastomosis done for thrombophilia four years ago. He appears in perfect health to-day, although his original trouble is not cured. It is to be regretted that the patient is out of town. In the future more will be heard of arteriovenous anastomosis for the symptomatic treatment of this trouble.

## OLD DEPRESSED FRACTURE OF THE SKULL; JACKSONIAN EPILEPSY; BRAIN CYST; CRANIOTOMY WITH FAT TRANSPLANTATION

Dr. Meyer presented a lad, eighteen years old, who was hit, when in his seventh year, by a man whom he was watching split wood with an axe. He sustained a compound depressed fracture of the left parietal bone with great injury of the brain. He was brought to a nearby hospital, where he stayed for a few months, his wound healing slowly.

He slowly developed spasmodic contraction of the right hand and also partially of the toes of the right foot, and in the last months before his admission to the German Hospital, Jacksonian epilepsy. The question was whether one could possibly help such a patient with a surgical interference so many years after the injury. At the operation the scars were excised and the depressed bone exposed; a few holes were bored into the skull and cut through with a Gigli saw. A part of the bone was then carefully removed. When lifting out the bone a large amount of clear fluid suddenly escaped. A brain cyst had been opened, the wall of which was partially formed by portions of the formerly torn dura mater. Excision of this wall was done and the adhesions of dura and skull all around thoroughly loosened with the finger.

In order to provide against reformation of adhesions of the brain to

the skull, a fat transplantation from the abdominal wall was added. The transplant surrounded the defect of the dura mater in all directions. The wound was then sutured and closed without drainage.

The patient made a good recovery. There is now a small opening due to a partial necrosis of the bone at one point which was divided by the saw. So far the epileptic attacks which he had before the operation have not returned.

### DUODENAL ULCER: SUBHEPATIC ABSCESS: DRAINAGE THROUGH PERTHES' INCISION

DR. MEYER presented a man who was operated upon three months ago. He had had signs of duodenal ulcer, and two days before admission to the hospital had a sudden sharp pain in the right hypogastrium, also in his right shoulder and in the median line between the xiphoid, followed by fever.

Analysis of the duodenal contents showed normal bile and pancreatic juice. Yet it seemed that the gall-bladder had to be accused as the cause of the acute trouble.

After a number of days of further analysis and observation Perthes' incision was made, the advantages of which have been seen by the speaker in quite a number of cases. By means of a rectangular incision, dividing the rectus muscle transversely, a skin muscle flap is turned up, thus saving the intercostal nerves that enter the rectus muscle. Then the second incision is made in front of and parallel with the costal arch, giving a most beautiful access to the upper abdomen. In this case this incision was selected in order to be prepared for all emergencies. The omentum, it was found, had been drawn towards the liver. On loosening it a large amount of foul pus was suddenly discharged from below the liver. The gall-bladder was found way down beneath the liver at the posterior aspect of the peritoneal cavity lying in a horizontal direction; it was somewhat changed in its shape, but contained no stones. There was no reason to puncture or to remove it. In the patient's precarious condition such was considered to be a wrong procedure. A distinct infiltration was palpable at the posterior aspect of the duodenum close to, but distal from, the pylorus. Culture of the pus showed streptococcus.

The abscess cavity was thoroughly drained and the greater part of the two incisions closed by sutures, the drains' exit being at the upper angle of the wound. The space beneath the skin muscle flap was also drained.

The patient made a good recovery, duodenal feeding being commenced two days after the operation. To-day he is perfectly well. His abdominal wall is perfectly solid.

### RIGHT BRONCHIECTASIS; LIGATION OF THE BRANCH OF THE PULMONARY ARTERY FOR THE LOWER LOBE OF THE RIGHT LUNG

DR. MEYER presented this case because the speaker believed that in this present time of the evolution of thoracic surgery the result of a rather con-

servative operation appears to be of some interest. The operation was performed four years ago, in February, 1913. The patient, who was then twenty-two years old, was very much annoyed by frequent expectorations of a large amount of very foul mucopus, which made it impossible for him to stay at work.

At the time ligation of the branch of the pulmonary artery had just been proposed by Sauerbruch for the treatment of bronchiectasis. The lung, deprived of its physiological work by the ligation of the vessel, becomes solidified and adherent to the chest wall. After this thoracoplasty is added and the lung permanently compressed.

This was the third case operated upon in this way by the speaker; the patients recovering nicely from the operation. This operation was done in the negative chamber under regional novocaine-adrenaline anæsthesia. Details of this case were published in the ANNALS OF SURGERY a few years ago. To-day the patient is in good condition. His expectoration has become reduced from 350 to 400 cm. permanently to 15 to 30 cm. in twenty-four hours.

## PNEUMOTOMY FOR BRONCHIECTASIS

DR. MEYER presented a man thirty-two years old, who came under his care in January of this year. Five months before he had passed through a severe attack of pneumonia, in the wake of which continuous expectoration of foul-smelling mucopus followed. Clinical examination, radiography and bronchoscopy pointed to an affection of the left lower lobe and to bronchiectasis rather than to a larger cavity formation (abscess). Under intratracheal insufflation anæsthesia an incision was made in the seventh intercostal space surrounding the lower half of the scapula. The free pleural cavity was entered; but farther back towards the spine the lung was tightly adherent to the chest. Because of the trouble being present for four months only, and the lung not showing the brown discoloration as is usually seen in cases of advanced bronchiectasis, it was decided not to do lobectomy but pneumotomy.

With the adherent lung in view aspiration was done, the needle being passed first through the undivided portion of the intercostal muscles. Pus was found. In view of the fact that the free pleural cavity was opened, the needle of the aspirator could not be left in place to be the guide for opening the abscess. It had to be withdrawn, the point of entrance being compressed by a gauze tampon.

Now a drainage tube, slipped through a hole in the centre of a round piece of cork, was placed in the pleural cavity, air-tight, under the guidance of the operator's eyes, in one of the lower intercostal spaces (Kenyon's method) and the opened portion of the free pleural cavity closed. When the needle was now put back in the same place of the adherent lung, where pus had first been found, the latter was not struck. However, a larger amount of air was aspirated into the well-working record-syringe. The

aspiration of air from the lung tissue is in cases of bronchiectasis just as important as that of pus. The cavity containing the pus simply was temporarily empty.

With the needle in place the cavity was then successfully incised with Paquelin's thermocautery. It was not very large but easily admitted two phalanges of the forefinger. It was distinctly seen to be irregular, clearly a part of the bronchial system. It was thoroughly drained with split rubber tubes and iodoform gauze and the dressing applied. After the patient had been returned to his bed the outer end of the drainage tube in the pleural cavity was connected with a bottle placed under the bed, the same dipping into a bichloride solution. Immediately air bubbles appeared in great numbers, proving that the lung expanded.

The patient had stood the operation nicely. On the second day his condition suddenly became very alarming, being due, it seemed, to the advent of an infectious pleurisy. However, because of the infected effusion developing having an outlet through the drainage tube the patient got over it nicely. Three days later his temperature was normal again. He was out of bed in the course of two weeks after the operation. At present he is back at work with his wound almost closed.[1]

## RESECTION OF THE CHEST WALL FOR ENDOTHELIOMA, ILLUSTRATING KENYON'S THORACIC DRAINAGE

The last case presented by Dr. Meyer was a woman fifty-one years old, in whom a hard sessile tumor was palpable below the right breast, corresponding to the mammary-pectoral skin fold. Under intratracheal insufflation and with the help of a large semilunar skin incision, the chest wall was exposed and then the tumor, with about 15 to 20 cm. length of four ribs, totally excised. After ligation of the feeding vessels the skin flap was carefully sutured back in place. Here, too, thoracic drainage was employed as described before, and the same smooth convalescence observed. After 48 hours, secretion from the pleural cavity had practically ceased.

Of course it cannot be said that the patient might not have made the same good and quick recovery without the drainage. However, there can be no doubt that the latter had been a very great point in favor of a quick recovery.

The speaker considers this kind of drainage to mean a tremendous advance in thoracic surgery. He will likely not operate a single case of primary thoracotomy any more, entering a non-infected pleural cavity, except using this drainage.

A few years ago the speaker had worked out at the German Hospital another method of free drainage of the pleural cavity after thoracotomy by leaving the patient under differential pressure for fifteen to twenty hours following the operation. But this method is cumbersome. It requires the permanent attendance of two nurses. Kenyon's method appears to be a

safe and simple procedure. It fulfils not only Sauerbruch's postulatum of air-tight closure of the chest after primary thoracotomy, but at the same time drains off the usually large amount of secretion which follows our work within the healthy pleural cavity in most cases.

*Stated Meeting, held May 9, 1917*

The President, Dr. Charles N. Dowd, in the chair

## FIBROMA OF THE ILEUM WITH INTUSSUSCEPTION

Dr. Frederic Kammerer presented a man, fifty-nine years of age, who, in September, 1915, began to suffer from intermittent colicky pains in the abdomen, of mild character. These gradually increased in severity. He was under observation for several weeks at the hospital when his illness began, where, with the exception of slight tenderness in the region of the descending colon, palpation revealed nothing. The X-ray examination was also negative. He has been suffering for the past one and a half years from indigestion, loss of appetite, flatulency and not very severe paroxysmal attacks of pain in the abdomen. He is not constipated and has never vomited. He was readmitted to the hospital in April, 1917, in a much run-down and rather anæmic condition. He has lost over 80 pounds in weight. During the first few days of observation nothing abnormal could be felt within the abdomen, but on the day preceding operation a mass about six inches long was detected in the left lower quadrant. There was no distention present, but on manipulation of the abdomen slight visible peristalsis could be noticed. The X-ray picture was inconclusive. On opening the abdomen an intussusception was easily found in the lower ileum, ending about eight inches from the ileocæcal valve. The same was about eight inches in length, the tip of the intussusception being a globular, elongated mass. By expression and traction we were able to reduce the intussusception to the extent of several inches, but further attempts were not made, as the lymph-glands in the mesentery, corresponding to this section of the intestine, were very large and presented a hard, nodular appearance. On the assumption that we were dealing with a malignant tumor, an extended resection of the mesentery was done, necessitating the removal of three and one-half feet of the small intestine. The proximal end of the bowel was closed and its distal end, situated two inches from the cæcum, was implanted, end to side, into the former. The patient made an uneventful recovery. From the pathologist's report (Dr. Humphreys, of the German Hospital) he quoted the following: The lumen of the distal 15 cm. of the resected ileum is occupied by a large pear-shaped tumor mass, approximately 10 cm. in length by 6 cm. in diameter at its widest part. The greater bulk of the tumor, including its wider end, lies free within the lumen of the intestine. The smaller end comprises the pedicle by which it is attached to the wall of the

[1] At time of correcting report the wound is closed.

gut. The mucosa covering the pedicle is eroded and ulcerated but not deeply so. The surface of the globular tumor is also fairly smooth, but discloses over it numerous small circumscribed nodules a few mm. in diameter, of somewhat firmer consistence than the rest of the tumor. The wider portion of the tumor is elsewhere covered by a fairly smooth appearing mucous membrane, the narrow portion by an ulcerated and eroded one. In the mesentery are found several enlarged masses, evidently enlarged lymph-nodes. One of these is about the size of an egg. *Anatomical diagnosis:* Pedunculated fibroma of the intestine with intussusception and inflammatory œdema in mesenteric lymph-nodes. Among the benign tumors of the small intestine pure fibromata appear to be rather uncommon, lipomata, adenoma and myomata being more frequently encountered. When such things give rise to an intussusception they generally lie at the apex of the invagination, and in the vast majority of cases the intussusception is responsible for the clinical symptoms, tumor having existed for some time and escaped detection. In our case, no doubt, the final invagination was of the acute variety, as a tumor was found only on the day preceding operation. This, of course, does not signify that former attacks of colic were not accompanied by invagination and later spontaneous reduction. At the operation no adhesions were found between the two layers of the intussusception, which fact also supports the view that the invagination was of recent occurrence.

As to the resection of three and one-half feet of intestine, fortunately followed by recovery of the patient, it is but fair to say that it later proved to have been an unnecessary procedure. The more radical operation was done on the assumption of malignancy. The large nodular lymph-nodes and the cachectic look of the patient seemed to justify this view. The appearance of the tumor itself was rather against it. In a number of cases of sarcoma of the small intestine reported in the literature of the subject metastatic glands are spoken of in the mesentery, but of a microscopical examination of the lymph-nodes no special mention is made. In a number of these, as in his own, the glands may also have been simply of an inflammatory nature.

Dr. Ellsworth Eliot said that this case presented several unusual features. In the first place, the loss in weight of eighty pounds is something that, in a review of the cases reported in the article to which Dr. Kammerer has referred, was rarely if ever mentioned.

Then, it is also of interest because of the glands involved. Again, if his recollection served him correctly, he found no instance of glandular involvement as a result of infection from the surface of benign growths. The benign growths themselves were rarely ulcerated. The mucous membrane in these cases was always intact. It is interesting to note that tumors in the small intestines, with or without intussusception, are almost invariably benign, while those in the large intestines are in about three-fifths of the cases malignant.

Dr. Eliot had seen only one case of carcinoma in the small intestine. This was situated within six inches of the ileocæcal valve, and was resected. The patient died four months later of metastasis of the liver.

Cases of carcinoma in the small intestine, with or without intussusception, are very malignant, much more so, in fact, than malignant tumors in the large intestines. Dr. Kammerer's case perhaps corresponds with one which was reported in the paper referred to, in which the symptoms simulated those due to an obstruction by fecal impaction. The mass extended from the neighborhood of the splenic flexure across the transverse colon and down the ascending colon. This mass disappeared after a high oil enema and yet with no substantial discharge of gas and fecal material. Shortly after the tumor reappeared and during the following fortnight it presented the typical features of a chronic intermittent intussusception.

After three weeks, the condition was complicated by chronic bronchitis and emphysema. On operation a tumor of the same character as that reported by Dr. Kammerer was found in the lower part of the ileum. When intussusception had taken place it had passed through the ileocæcal valve into the ascending colon and around the hepatic flexure into the transverse colon. From this rather advanced position it had receded from time to time in the manner described, without any material symptoms. At the time of the operation the tumor of comparatively small size was easily reducible until the ileocæcal valve was reached, through which it was reduced with some difficulty. The final part of the intussusception could not be reduced, and required resection. I believe this to be, without question, the appropriate treatment in these cases.

The second case that was reported in the paper referred to emphasized the point that the clinical features in these cases of intussusception vary very widely. It was one of the most stormy cases of acute intestinal obstruction that he had ever seen. The patient was brought to the hospital in the middle of the night with intense abdominal pain and bloody stools. The abdomen was distended and the coil of intussuscepted intestine could be distinctly felt on either side of the abdomen. Immediately operation was done and an intussusception two feet in length was found. Even the slightest reduction was impossible and the entire mass was resected.

Both patients, fortunately, recovered. The technic differed from that employed by Dr. Kammerer in that the continuity of the intestine was restored by end-to-end anastomosis.

There are also cases that are not due to tumor, and perhaps it is just as well to refer to them, because of their acute character. He referred to intussusception associated with a Meckel's diverticulum. In the preparation of the paper referred to by Dr. Kammerer, he found in the literature 10 or 12 cases of acute intussusception of the ileum in patients of from fifteen to twenty. These cases were all cases of acute irreducible intussusception.

Dr. John F. Connors said that in July of last year there was admitted

to his service at Harlem Hospital a case with the diagnosis of acute appendicitis, who, after being kept under observation for twenty-four hours, developed signs of intestinal obstruction. At operation there was found an intussusception about two feet from the ileocæcal valve. When this was reduced it contained a hard mass about the size of an egg, which reduced the lumen of the gut about two-thirds its normal size. About twelve inches of intestine was resected, followed by end-to-end anastomosis, a single enlarged gland was removed from the mesentery. The pathological report showed the tumor and gland to be a round-celled sarcoma. After operation the patient's weight rose from 90 to 135 pounds. In February of this year he returned to the hospital, complaining of the same pain in his abdomen. After being in the hospital for forty-eight hours he again developed signs of obstruction. At the second operation another intussusception was found about three feet from the first one which was exactly like the one found seven months previously. He had besides this two other tumors of equal size about one foot from the intussusception. About three feet of intestine were removed, containing the masses, and a lateral anastomosis was done.

At the second operation all the mesentery was found filled with glands, the tumors and glands proved to be round-celled sarcoma. After this operation he picked up and is still doing very well.

Dr. Dewitt Stetten said that he reported on the submucous lipoma of the gastro-intestinal tract some eight years ago, in connection with a rather unique case that was sent to the hospital with the diagnosis of prolapse of the rectum. On examination, the patient presented at the anus a pedunculated, mucous membrane covered mass that suggested a polyp of the sigmoid. It was impossible to feel the end of the pedicle, but it certainly was not a prolapse of the rectum. It looked very much more like a polyp of the sigmoid or descending colon, and with that diagnosis he operated on the patient. He found the mass to be a chronic ileocæcal intussusception due to a large lobulated, polypoid submucous lipoma of the ileum which had travelled through the entire large intestine. A Maunsell resection and anastomosis were done, and the patient made an uneventful recovery.

He was present at Kammerer's operation and he would also like to emphasize the difficulty in making the diagnosis as to the character of the tumor. To all appearances, at the time of the operation, this was a malignant tumor. He examined the specimen immediately after it was removed, although he did not open the gut. Even then he had very little suspicion that it was a benign tumor, particularly when he looked at the mesenteric glands. He even incised one of the larger glands and it seemed to show malignant infiltration.

## FOUR KINDS OF APPENDICITIS

Dr. Robert T. Morris read a paper with the above title, for which see page 560.

# TRANSACTIONS

OF THE

# PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting, held May 7, 1917*

The President, Dr. CHARLES H. FRAZIER, in the Chair

## SPLENECTOMY FOR PERNICIOUS ANÆMIA

DR. J. STEWART RODMAN reported the history of a man, aged thirty-nine years, who was admitted to Dr. Sailer's service August 13, 1916, suffering from asthenia. He had been well until five weeks before admission when he began to have daily attacks of abdominal pain, with chills and sweats, and an attack of vomiting every other day. No blood in the vomitus nor in the stools. Lost weight rapidly—thirty pounds during the period. He was markedly pale and anæmic; eyes prominent, skin icteroid; tender under right costal margin; spleen not palpable; no adenopathy—urine albuminous but free from casts and sugar; on admission red blood-corpuscles were 2,580,000; hæmoglobin, 30 per cent. Two weeks later the red count had fallen to 1,050,000 with hæmoglobin 20 per cent. A blood transfusion of 150 c.c. was done September 17, which raised the red count to 3,420,000, with hæmoglobin 30 per cent. October 18, the red count had fallen to 3,100,000 with hæmoglobin 35 per cent. A splenectomy was resorted to October 19, being done by Drs. Allen and Rodman.

The removed spleen was one and one-half times its normal size; was adherent to stomach, pancreas, colon and diaphragm. Moderate hemorrhage. Pedicle clamped and double ligated. Gauze packing to diaphragmatic surface. The gauze was removed five days later. The postoperative course was uneventful. On October 24, five days after the removal of the spleen, the red count had risen to 3,250,000, hæmoglobin 44 per cent.; three weeks later the red count had risen to the normal level of 4,470,000 with hæmoglobin 45 per cent. The patient was discharged home November 15, 1916.

## GUNSHOT WOUND OF THE SPINAL CORD

DR. J. STEWART RODMAN reported the history of a man aged thirty-four years, who was admitted to the Presbyterian Hospital, in the service of Dr. F. O. Allen, December 17, 1916, on account of a gunshot wound of the neck.

The bullet had entered posteriorly on the right side at the base of the neck. He was unconscious when admitted but regained consciousness shortly after admission. Temperature 100 degrees. Pulse 80. Complete paralysis of upper and lower limbs. Loss of sensation to upper third of chest. Loss of bladder and rectal control. An X-ray plate showed a bullet in the spinal cord about the level of the fifth cervical vertebra.

*Operation.*—(Gas and oxygen.) Drs. J. S. Rodman and F. O. Allen.

Laminectomy; spines and laminæ of fifth, sixth, and seventh vertebræ removed. Fourth and fifth vertebræ fractured by bullet, 38 caliber bullet removed from spinal canal at level of fourth cervical vertebra. After lifting bullet from its bed it was seen that the spinal cord was completely divided at this level; wound closed with gauze drainage.

## TRAUMATIC BRACHIAL PARALYSIS.

Dr. Astley P. C. Ashhurst presented a man, aged fifty-four years, who was referred by Dr. J. H. Baldwin to his service at the Orthopædic Hospital, June 10, 1916. On March, 1916, this man had fallen and injured his left shoulder. One week after the injury the man applied to Dr. Baldwin, who sent him to the Methodist Hospital. Paralysis was present at this time. Dr. Baldwin found the whole limb much swollen, and recognized the presence of an unreduced dislocation of the shoulder (subcoracoid); this was reduced at the hospital under primary anæsthesia by Dr. L. J. Hammond. The patient went home eight days after the dislocation was reduced, in good condition. Two weeks after leaving the hospital he says his arm began to swell; he had considerable constant pain like pins and needles radiating from the shoulder to the fingers. He then returned to the Methodist Hospital, where he remained six weeks, receiving massage and electricity.

*Examination,* June 10, 1916, three months after the injury, when first seen at the Orthopædic Hospital, showed a healthy looking man, with the left upper extremity hanging helpless at the side of the body. There was no *voluntary motion* below the shoulder except very slight power in the triceps, sufficient merely to extend the elbow a trifle, and very questionable power of pronating the forearm. The arm could be elevated from the side by means of the trapezius acting on the scapula. There was good power in the pectoralis major. There was noticeable atrophy of the deltoid. There was no power to flex the elbow, nor to move the hand or fingers. The hand was slightly swollen. *Passive motion:* at the shoulder external rotation was limited at the sagittal plane, abduction at 35 to 40 degrees (without causing rotation of the scapula); other passive movements were normal except slight loss of full extension of the elbow. There was some grating in the shoulder on motion, and some thickening of the bones.

*Electrical examination* by Dr. H. P. Boyer, June 12, 1916, showed reaction of degeneration in the deltoid, biceps, triceps and the flexors and extensors of the carpus and fingers. The response was very poor to the galvanic current, and there was practically no response at all to the faradic current.

*Treatment* consisted in massage and electricity three times weekly. The question of exploratory operation was discussed with the patient, but not urged very enthusiastically, and was not accepted by him.

July 1, 1916. The elbow and hand swell at times. He thinks he has more power in the shoulder and elbow, but none is apparent on examination.

September 16, 1916. The patient says that sensation, which was absent below the elbow when he first came to the hospital three months ago, has returned very gradually and now is about normal from the wrist up. In the hand hypæsthesia (no anæsthesia) persists. The patient was seen at this time by Dr. Francis W. Sinkler, who believes the lesion to have been a laceration of the nerves in the axilla. Examination to-day (September 16) shows no power to flex the elbow, though the biceps can be felt to contract voluntarily; there is doubtful voluntary power in the brachialis anticus; but he is unable to flex the elbow even when the forearm is hanging vertical like a pendulum with the arm held horizontal. There is fair power in the triceps. The elbow cannot be fully extended passively. He is able to abduct his shoulder to about half the normal extent, and the deltoid can be felt contracting. There is almost normal active flexion and extension of the shoulder. There is good pronation and weaker supination of the forearm, the latter being accomplished mainly by the biceps, which can be felt to contract though it is not strong enough to flex the elbow.

September 25, 1916. *Electrical examination* by Dr. Boyer shows no change from that of June 12, except that the deltoid no longer shows reaction of degeneration.

April 14, 1917. The patient, who still comes three times weekly for massage and electrical treatments, says that up to about two months ago he could not feel hot water in the hand; he could put it in "boiling water" he says, and not know it. Now, however, sensation is normal. *Active motion:* shoulder can be abducted to 60 degrees, the deltoid seems normally active; flexion and extension of the shoulder are almost normal; internal and external rotation are good, but the latter is limited at the sagittal plane. Flexion and extension of the elbow are good, but flexion is still a little weak. Flexion of the wrist is *very* weak, but there is fair power of extension. There is full supination, and pronation to the mid-position, both of fair strength. There is very little movement in the fingers, consisting only in very feeble flexion and extension; there is no power to separate the fingers. The thumb can be moved slightly in flexion and extension. *Passive motions:* at the shoulder there is no more passive than there is active motion. At the elbow the range of passive motion is from 60 to 160 degrees. Rotation in the forearm is normal. The wrist extends almost normally, flexes two-thirds normal. The fingers and thumb can be flexed half the normal extent, and can be fully extended.

May 4, 1917. *Electrical examination* by Dr. H. P. Boyer: There is marked improvement shown. The deltoid, biceps, triceps, and extensors of fingers do not show reaction of degeneration, and respond fairly well to the Faradic current. The flexors of the fingers still show reaction of degeneration and do not respond to the Faradic current.

Dr. Ashhurst added that he thought the diagnosis in this patient was correctly given by Dr. Sinkler as a laceration of the nerves in the axilla. The laceration probably was slight, consisting rather in stretching than any

actual solution of continuity. The effusion of blood, lymph, and synovial fluid no doubt also was in some measure responsible for the disability. The prognosis probably is good in this case for ultimate recovery even of the hand; though when the patient was first seen, and especially when it was found that reactions of degeneration were so complete, there seemed little hope of ultimate recovery.

Dr. Ashhurst recalled that Duval and Quillain (1898) maintained that all nerve lesions accompanying injuries by indirect violence at the shoulder were either *radicular* or *terminal,* there being no such clinical entities as ruptures of the brachial plexus. Also that Delbet and Cauchoid (1910) had collected 36 cases of paralyses, complicating dislocations of the shoulder: 25 were *terminal,* and were caused by the dislocation; 11 were *radicular,* and were caused *not* by the dislocation, but by the same cause which produced the dislocation. In this series there were no lesions of the brachial plexus proper.

The present case, therefore, supports these investigations.

Dr. T. Turner Thomas said that it has long been the tendency to attribute all traumatic brachial paralyses of a diffuse character to injuries of the brachial plexus because a nerve rupture involving so many muscles could not be located anywhere else. The late results, according to his experience, show that almost every case recovers completely from the paralysis. The sensation is rarely disturbed seriously, and in almost every case the shoulder-joint is stiff and painful, indicating that it was injured.

For six years he had been trying to show that the paralyses in most of these cases is secondary to the shoulder-joint injury and disappears with the complete recovery from this joint injury, sometimes before. The greatest difficulty is in deciding what cases may properly be included under the traumatic brachial paralyses. Some surgeons believe that the Duchenne-Erb paralysis (C V, and C VI) is common in adults and serious, while most surgeons ignore it entirely in their practice, and it is given no place in surgical text-books. Yet few surgeons, probably, would deny that traumatic brachial palsy of varying degree from injury in the shoulder region is frequent but rarely permanent. The fact of the matter is that discussion of the subject is being avoided.

He recognized two main classes of these cases. In the first, by far the most common, the shoulder-joint becomes stiff and painful, but is in no sense flail. These recover completely with the restoration of normal function in the shoulder-joint or even in the presence of a considerable permanent ankylosis. In the second the causal force dropped a half inch or inch below its normal level under the acromion, and later the joint became flail when the pain and muscle rigidity disappeared, and especially when the resulting atrophy became marked. Early removal of the flail condition of the joint and then of motion, the operative stiffness is followed by a complete cure. In other words, the operation puts the joint into the condition found in the first class, which is then overcome.

Not infrequently there will be found in both groups, from the shoulder

to the ends of the fingers, marked pain and tenderness in all of the structures, with pain and stiffness in all of the joints, much worse in the hand than elsewhere. This condition is present in Dr. Ashhurst's case and is now the only condition to be reckoned with. It is not peculiar to shoulder injuries. LeBreton has reported a series of cases following Colles's fracture. In all of his cases with flail shoulder, four in number, except the first seen five years ago, there was more or less swelling in the hand, extending a variable distance upward. It may have been present in his first case before he saw it, nearly five weeks after the accident. He had had at least as many cases without flail shoulder. He doubted if a patient with a marked case of this condition can ever again have a normal hand, because adhesions have developed between all of the tendons and their sheaths, in addition to the trouble in the joints, and he could not believe that the adhesions would disappear and the tendons work freely in their sheaths again.

## CANCER OF THE PENIS

Dr. B. A. Thomas reported the history of a man, aged thirty-seven years, who was admitted to the Polyclinic Hospital on January 4, 1917, with the following history: He had had a phimosis all his life, and had never been able to retract the prepuce. One year ago he noticed a slight discharge from the penis, but did not pay any attention to it at the time. The condition grew worse for a while, and a few months later the glans penis began to recede from the margins of the prepuce, and to swell at the same time. There has been a bloody discharge from the ulcerated area for most of the time during the past year. At the time of admission the end of the penis presented a huge cauliflower growth, which, together with the œdematous loose connective tissue, measured about four inches in diameter. The growth apparently had its origin in the region of the coronal sulcus on the dorsal aspect of the organ, but at the present time by contiguity has involved three-fourths of the circumference of the infiltrated organ, merely a portion of the glans in the region of the meatus being free. The inguinal lymph-nodes on both sides were palpable. The Wassermann reaction resulted negatively.

On January 5th patient underwent operation, consisting of bilateral inguinal lymphadenectomy and total extirpation of the penis, the incision extending downward from both inguinal regions, meeting and encircling the root of the penis, thence downward, dividing the scrotum to the middle of the perineum, after which the corpora cavernosa were freed from their attachments to the rami of the ischium. The bulb of the penis was then divided, the urethra severed and anastomosed in the perineum at the lower angle of the incision, after which the wound was closed. The histopathological report stated growth to be a squamous-celled carcinoma of the penis, with very early metastasis to the inguinal lymph-nodes.

A few days after the operation, X-ray treatment was begun as follows: For three days, each day, he was given six exposures of ten minutes each,

at different sites. This was repeated in three weeks, and again in four weeks, the last treatment being given after he was discharged from the hospital, which was on February 5. The patient's convalescence was remarkable in the fact that a week after his discharge from the hospital he was employed as a chair-pusher on the boardwalk at Atlantic City. Seen two months after he left the hospital, he was still at this occupation, experiencing no discomfort and had not any incontinence of urine, difficulty on urination, or evidence of contracture of his new external urinary orifice.

## HYDROCELE OF EXTREME SIZE

Dr. Thomas presented a man, aged seventy-three years, who was first seen on March 26, 1917, at the Surgical Out-patient Department of the University Hospital, complaining of a huge rupture. He stated he had been the victim of herniæ on both sides for twenty years. Eleven months ago he fell, striking his herniæ, after which swelling began on the left side, and increased rapidly. At the present time the mass is so large that the patient is obliged to carry it in a hammock, suspended from his shoulders, by improvised suspenders. The penis is almost lost to view, becoming invaginated in the tumor, and appears as an inconspicuous dimple on the right side. The act of urination is accomplished by pressing a funnel against the skin below this dimple, which diverts the urine to a receptacle. The tumor is cystic in character, and fluctuates, and seems to be about two-thirds fluid, transmitting light in the lower two-thirds. This swelling, complicating the hernia on the left side, is remarkable chiefly because of its size, measuring 41 centimetres on its vertical diameter, and 81 centimetres in circumference. The hydrocele was tapped, any other form of treatment being out of the question, and sixteen pints of fluid were removed.

## MYOSITIS OSSIFICANS PROGRESSIVA

Dr. B. A. Thomas and (by invitation) Dr. F. G. Harrison presented a little girl, four years of age, with the history that about February, 1916, the mother noticed a lump in the child's back in the lumbo-thoracic region, which she says appeared after a fall while at play. This grew larger, and other lumps appeared, and her neck became stiff. She has grown progressively worse. She has never complained of pain. There is no history of any lumps disappearing. There is limitation of motion of the spine, shoulders, and hips. There is a loose body in the right axilla, the others are all immovable.

There is an evening rise of temperature, no cough. Wassermann is negative. She plays around with other children.

*Family History.*—Father living and well. Mother has pulmonary tuberculosis. She has been deaf for seven years and has grown progressively worse lately. Has had eight children, three dead of causes uncertain, four others, besides patient, well.

*Previous Medical History of This Child.*—Normal birth. The mother says there was a congenital malformation of the great toe, hallux valgus. The child was breast fed for three months. Had measles prior to her trouble, whooping cough when she fell, and chicken-pox afterward.

## INDICATIONS AND TECHNIC FOR REMOVAL OF THE SPLEEN

A paper with the above title was presented by Drs. George P. Müller and Charles H. Frazier.

Dr. P. G. Skillern, Jr., called attention to the very excellent method of controlling the blood-supply in splenectomy which the essayists did not mention; this was suggested by J. C. A. Gerster (*Jour. Am. Med. Assoc.*, August 7, 1915), who believes that ligation of the arterial supply of the spleen at certain points which are more accessible than the deeply situated pedicle will greatly facilitate difficult splenectomies. These points are (1) the splenic artery close to the cœliac axis; (2) the gastro-epiploica sinistra where it reaches the stomach from the splenic. The cœliac axis is readily exposed through the lesser omentum just above the lesser curvature of the stomach and border of the pancreas, and may be made to come within one inch or so of the anterior abdominal wall by hyperextending the spinal column as for gall-bladder operations. This method should be applicable in certain cases of Dr. Müller's Group I, namely, in certain cases of traumatic rupture of the spleen, especially those cases where there is already severe traumatic shock, to which the addition of the surgical shock attendant upon splenectomy might surpass the margin of safety and kill the patient; in these cases mere ligation of the splenic artery with, if thought necessary, stuffing of the great omentum in the splenic rent, should suffice to bring about the immediate recovery of the patient. In cases of removal of the spleen for disease, in which there are numerous vascular adhesions conveying a vicarious exotic circulation to the spleen, ligation at these two points would serve to diminish the hemorrhage, but not to control it entirely.

By ligating the splenic artery at its origin a "safety first" principle is observed, precautionary against hemorrhage due to unforeseen accidents during or after operation; thus, after mobilization and delivery of the spleen its pedicle might be found to be very short and hard to clamp and ligate; and Dr. Frazier mentioned the possibility of the ligature slipping off the pedicle—a catastrophe for which there is no excuse, and one which can be prevented by anchoring the pedicle ligatures with two or three additional small ligatures.

As to the incision, Dr. Müller stated that he employs a long, vertical cut through the left rectus. For upper abdominal work the transverse incision, advocated last year by Moschcowitz, seems advantageous upon anatomic grounds. This incision divides one or both recti transversely two inches above the navel and is continued transversely outward through the flat muscles of the flank as far as conditions warrant. The advantages of this transverse incision are freer exposure and less damage to the abdominal

wall. With the exception of the rectus the muscles and congeries of minute tendons into which they insert are cut parallel with their fibres, instead of at right angles, as with all vertical incisions; for the same reason, the motor nerves, too, escape division. As regards dividing the rectus muscle transversely, the ultimate result is but the addition of another transverse cicatricial intersection to the three or more tendinous ones normally present. The scar resulting from the wound is stronger and its cutaneous portion eventually almost invisible. The transverse incision, however, takes more time, and when time is an important element, the linea alba incision, as advocated by Percy, could be employed.

## TRAUMATIC BRACHIAL PARALYSIS WITH FLAIL SHOULDER-JOINT

Dr. T. Turner Thomas read a paper with the above title, for which see page 532.

Dr. Nathaniel Ginsburg said that he had observed and treated three cases of traumatic brachial paralysis in adults. The first patient (Figs. 1 and 2) was seen in July, 1912, and then presented a total paralysis of the shoulder girdle and arm, except for part of the supraspinatus and trapezius muscles. The intercostal humeral nerve was intact. There were marked trophic changes in the extremity, and he suffered from intense shooting pains in the forearm, hand, and fingers. On January 13, 1912, the injured extremity was caught in a heavy leather machinery belt. He remembered nothing of the injury until he awakened in the hospital, and was then told that his collar bone had been broken. The extremity was bandaged to his side for three weeks, at the end of which time it was discovered that a severe nerve injury had taken place. A careful dissection of his brachial plexus was made in the Polyclinic Hospital, and the cords were found totally disorganized and beyond operative repair.

The second case (Figs. 3 and 4) was observed in the Jewish Hospital in August, 1916. The patient was a fireman, twenty-three years of age, whose left shoulder and lower cervical region were struck by a locomotive running in the opposite direction while he was leaning out of the cab in which he was riding. He suffered a traumatic avulsion of the cervical and brachial nerve trunks, resulting in total paralysis of the left upper extremity, with some sensation persisting corresponding to the distribution of the intercostal humeral nerve. He also sustained a fracture of both bones of the forearm of this extremity near the wrist joint and a fracture of the neck of the scapula. The inequality of his pupils at the time of his admission and also at the present time is marked. Operation, seven weeks after the injury, exposing the left cervical and brachial plexus with division of the outer third of the clavicle revealed the presence of intraspinal avulsion of some of the cervical nerve trunks entering into the formation of the brachial plexus, with complete division of some of the lower trunks. The dissociation of the cords entering into the formation of the brachial plexus was so marked and the perineuritic changes so extensive that it was not possible to satisfactorily make new

FIG. 1. FIG. 2.

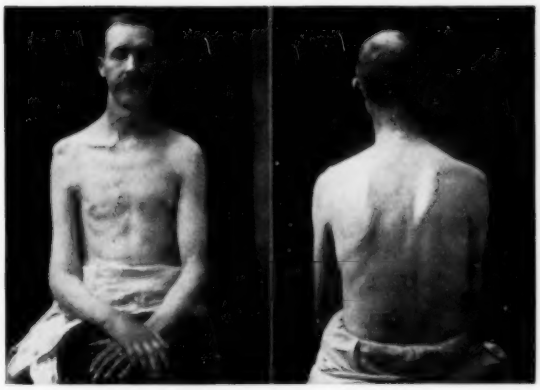

FIG. 1 and 2.—W. F. B., aged forty-four years. Traumatic rupture of brachial plexus. Injury January 13, 1912. Extremity caught in heavy leather belt of machinery. Remembered nothing until he awoke in the hospital, when he was told that his collar bone was broken; the arm being bandaged to the side for three weeks. July 27, 1912: Total paralysis of the shoulder girdle and arm, except for part of the supraspinatus and trapezius; intercostohumeral nerve intact; trophic changes in the extremity and intense shooting pain in the hand and fingers. Operation, July, 1912; disclosed rupture of the brachial plexus trunks.

FIG. 3. FIG. 4.

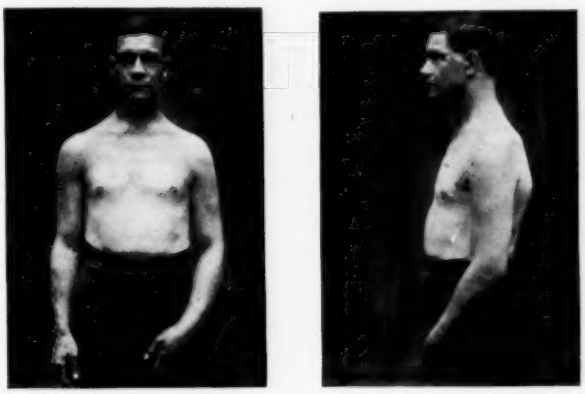

FIG. 3.—C. S., aged thirty-three years; fireman. Traumatic avulsion of the brachial plexus. Total paralysis of the left upper extremity with some sensation corresponding to the distribution of the intercostohumeral nerve. Operation: Partial anastomosis of intact cords. No result attained.

FIG. 4.—Same patient as Fig. 2. Lateral view, showing left upper extremity, following an injury to the cervical and brachial nerve trunks. Fractures of both bones of the forearm near the wrist and fracture of the neck of the scapula, complicating the injury to the nerve trunks.

FIG. 5. FIG. 6.

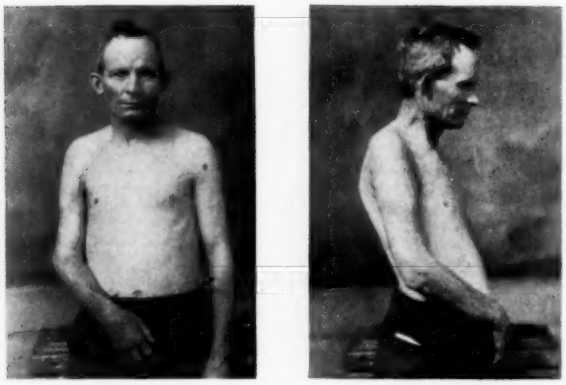

FIG. 5.—C. A. C. Traumatic brachial palsy of the right upper extremity, as result of being struck by a controller in the supraclavicular region, with coincident partial fracture of the head of the humerus. Note the atrophy of the shoulder and right pectoral region, with swelling of the extremity.

FIG. 6.—Same patient as Fig. 4. Lateral view. Note the suprascapular and deltoid and right pectoral atrophy. Some use of the muscles corresponding to the distribution of the median nerve is present. Marked involvement of the ulnar and musculospiral nerves. Decided improvement under massage and electricity.

nerve anastomosis, although a few of the trunks which seemed intact were brought together and sutured. The operation has apparently failed to restore any function in this extremity, for he seems to be hopelessly injured.

In both these cases the primary injury was apparently extreme traction exerted upon the cervical cords, plus direct trauma compressing the brachial plexus between the clavicle and the first rib.

The third patient (Figs. 5 and 6) was seen through the courtesy of Dr. Zion, of Wilmington. The man was injured in a street car altercation, being struck in the right supraclavicular region, and sustaining a partial fracture of the head of the humerus. A careful examination showed a paralysis typical of a traumatic brachial palsy, with some preservation of function corresponding to the motor and sensory distribution of the median nerve. The atrophy and the trophic changes, as shown in the photographs, are characteristic of paralysis of the type under discussion. He did not believe that there was division of all the nerve fibres in this case, but thought a considerable amount of his injury was the result of the trauma sustained by the controller which struck him in the supraclavicular region. With the application of massage and electricity, he has made considerable improvement, although the last examination a short time ago still shows extensive involvement of his musculospiral nerve.

He had been much interested in the surgical treatment of those cases where total division or extensive injury of the whole brachial plexus has taken place. On the cadaver he had found that it is anatomically impossible to successfully transplant cords from the opposite side, because the trunks are too short if carried across the pretracheal region, and also because the shortest route across the neck, which is prevertebral, would necessitate an extensive dissection and expose the patient to grave injury. Again, where there is extensive or complete involvement of the whole plexus on one side, it would not seem wise to jeopardize the integrity of the sound side by longitudinal splitting of the nerve trunks.

It had occurred to him that if the upper intercostal nerves could be transplanted across the axilla into the trunks of the injured nerves, this operation would be indicated, since the intercostal nerves carry both motor and sensory fibres. Cadaver attempts to perform this operation have shown that the chief difficulties are first the danger of opening the thoracic cavity, since longitudinal resection of a number of ribs must be practised, and secondarily the intercostals are of surprisingly small size, even as far posteriorly as it is possible to reach them by the transaxillary route. One of these patients was exceedingly anxious to have this operation attempted, but he could not bring himself to believe that it would be justifiable to expose him to the risks of such an extensive procedure. All of these patients have bitterly complained of the intense neuritic pain in their hands and fingers from which they constantly suffer, and two have requested amputation of the injured extremity.

Dr. Ginsburg thought that Dr. Thomas had a little different conception of traumatic brachial paralysis from that which is generally held. The cases

of traumatic brachial paralysis which appear in the literature largely consist of reports of serious injury to many or all of the cervical or brachial nerve trunks entering into the formation of this plexus. The term is generally employed to express a break in the continuity of the nerve trunks, either partial or total, the severance occurring intra- or extraspinally.

The cases reported by Bristow, Murphy, Frazier, and Skillern, as well as the three patients whose cases he had briefly presented, were instances of injury to the brachial cords, sustained as the result of trauma and confirmed by operative findings. The injury disclosed in this class of cases at the operating table has been one definite and severe injury to the nerve trunks, with coincident perineuritic changes. The class of cases reported by Dr. Thomas would suggest rather a primary shoulder injury without the brachial plexus participating to any great extent; or it may be that in a number of his cases the deltoid muscle has been partially or completely paralyzed by injury of the circumflex nerve, owing to its close proximity to the neck of the humerus. Certainly, relaxation of the capsule of the shoulder joint cannot occur in the absence of partial or complete paralysis of the deltoid muscle, and this at once implies injury to a nerve structure. The absence of operative investigation of the brachial plexus in most of his cases does not sustain the belief that they belong to the type generally termed traumatic brachial paralysis.

Dr. Penn G. Skillern, Jr., remarked that Dr. Ginsburg, in his discussion of Dr. Thomas's paper, said that for the relief of cases of traumatic brachial paralysis where the spinal rootlets themselves were torn asunder, such as reported by Dr. Frazier and himself in 1911, he had conceived the idea of dividing the intercostal nerves and anastomosing their proximal ends with the distal portion of the brachial plexus. Such an anastomosis, even granting that it is practicable, would be but a drop in the bucket and quite like sending a liliputian on a giant's job, as far as concerns making up the loss of the great number of motor fibres possessed by the brachial plexus, especially when one considers that the upper six intercostal nerves carry only enough motor fibres for the supply of the small intercostal muscles alone; how far would these few motor fibres go when it comes to innervating the great muscular masses which move the upper limb?

Dr. T. T. Thomas quite agreed with Dr. Ginsburg that there are two kinds of traumatic brachial paralyses. What he was trying to show is that there are a great many in which there is probably no injury to the brachial plexus. No one who heard or read Dr. Frazier's paper of 1910 or 1911 on this subject, with its detailed report of a case in which the spinal canal was opened and an intraspinal rupture found, could fail to believe that real ruptures take place. On looking up the paper of Madame Klumpke on traumatic brachial paralysis of the lower arm type, he was struck by the number of cases that she collected which, with the one she reported, were almost exact counterparts of the one reported by Dr. Frazier. This type shows absolute loss of sensation and motion and never recovers. The cases he had been reporting have recovered fully from the paralysis and never

had serious impairment of sensation. Moreover, they all had associated injury of the shoulder joint.

## PARALYSIS OF BOTH TRAPEZII MUSCLES AFTER ABLATION OF CERVICAL LYMPH-NODES, WITH PROPOSAL OF A NERVE-ANASTOMOSIS OPERATION FOR CURE

Dr. Penn G. Skillern, Jr., presented a man, aged eighteen years, referred by Dr. Thomas Tigam, who was admitted to the Polyclinic Hospital (No. 31152) on April 24, 1917, for removal of recurrent tuberculous cervical lymph-nodes. He was discharged, cured, on May 3, 1917.

He had been operated upon one year before elsewhere, for on each side there was an operative scar four inches long along the posterior border of the sternomastoid muscle—diseased nodes evidently having been removed from the occipital triangle, and the trapezius branch of each spinal accessory nerve had been resected, for both trapezii were paralyzed and atrophied, bringing to the surface the deep anatomy of the shoulder girdle and base of the neck (Fig. 7). The patient stated that he noticed his shoulders drooping forward when he got up from bed after the operation.

The photograph shows beautifully the extent to which both shoulders droop forward. Both clavicles are prominent, and the supraclavicular fossæ are so deep that apical tuberculosis is suggested (Fig. 8). The upper border of the scapula with its notch can be plainly felt just beneath the skin: the vertebral border can likewise be felt. The spine of the scapula and supraclavicular fossa are easily palpable. In other words, conditions are such as would be expected from a knowledge of the origin and insertion of the trapezius muscle, given the presence of atrophy of this muscle. The head, too, is inclined forward. The fresh operation incision was made by the author to remove recurrent tuberculosis of the lymph-nodes: when the upper limb of this incision was made the scar from the previous operation was excised, so that the situation of the latter is indicated. It was necessary to divide the sternomastoid to reach enlarged nodes beneath its upper third; during this manœuvre the sternal branch of the spinal accessory nerve was seen sinking into the sternomastoid muscle and was lifted up with the muscle without injury. The region of the old scar on the left side of the neck was not reoperated upon. The levator scapulæ muscles stand out prominently and subcutaneously on both sides. Loss of function of these muscles is well compensated.

A similar case was presented by Vosburgh before the New York Surgical Society on April 22, 1914 (Annals of Surgery, 1914, lx, 762). In the discussion which followed, Mathews said he had seen the spinal accessory nerve accidentally divided and the injury not followed by shoulder drop, and also when its division was necessary, neurorrhaphy could be performed with very good expectation of reunion. Dowd, referring to the relative importance of the spinal accessory nerve and the branches of the cervical plexus in the innervation of the trapezius muscle, stated that in a much used

method of removing tuberculous lymphnodes the branches of the cervical plexus (III and IV) are sacrificed and the spinal accessory alone is preserved; and that while in many instances this is sufficient to provide good innervation to the trapezius, in other instances it might not be sufficient. Eliot found in a number of instances the development of these nerves differed very materially. In some cases the terminal branch of the spinal accessory passing to the trapezius was exceptionally well developed; in others it was not developed so well, while in rare instances it was entirely absent. Eliot also found that with a weak spinal accessory supply, the branches of the cervical plexus supplying the trapezius were exceptionally well developed, and *vice versa;* this might be accounted for by variations in the anastomosis between the spinal accessory nerve and the cervical plexus. In those cases where the spinal accessory supply of the trapezius was well developed, the degree of anastomosis between the cervical plexus and the spinal accessory was not well marked.

Reporting two cases of operative paralysis of the spinal accessory nerve, Bailey (ANNALS OF SURGERY, 1901, xxxiii, 558) states that serious disturbances of motion in both sternomastoid and trapezius immediately following operation, which obtained in his patients, contradicts the more common experience, for in most cases the paralysis which results from section of the nerve is not particularly disabling. Large pieces of the nerve are resected for spasmodic wry-neck without fear of serious loss of motor power; and in only a few of the reports of accidental section is any mention made of paralytic results of consequence. This is explained by the additional supply to the trapezius from the cervical plexus. When the sternomastoid is totally paralyzed, freedom of movement of the head and neck is impaired, but it is not abolished; even when both muscles are entirely put out of service, the erect position of the head is not seriously interfered with. With the rare exception of penetrating wounds at the base of the skull, extracranial lesions of the spinal accessory are always confined to the external branch, and are nearly always traumatic. Neuritis of this nerve is rare.

Paralysis of the trapezius is indicated by great disability in raising the shoulder and in adducting the shoulder-blade. The arm cannot be elevated much above an angle of ninety degrees; the sufferer is practically deprived of the use of his arm for all heavy work. Complete trapezius paralysis is a serious calamity to any one, but especially to a laboring man. Forming, as it does, the most important support of the shoulder, the loss of the trapezius practically does away with the power of lifting weights which are at all heavy. The deltoid, in losing its support, loses much of its usefulness, and lifting must be done by the flexion of the forearm and by a bending of the whole body.

The assumption that occasionally there is a variation from the customary route by which the motor impulses pass from the spinal cord to the trapezius receives some support from the fact that the trapezius is not, in its anatomic relations, a fixed muscle. In man it may be congenitally absent in whole or in part; in the lower apes it is supplemented by another similar muscle called

FIG. 7.—Oblique view of post-operative trapezius paralysis, showing forward droop of shoulders and of head. Note relative prominence of bones of shoulder girdle. Fresh scars due to reoperations for diseased nodes.

FIG. 8.—Anterior view of post-operative trapezius paralysis. Note depth of supraclavicular fossæ, simulating the depression produced by apical tuberculosis.

the spinocervicalis. Bailey takes this variation in the case of the trapezius to be as follows (Fig. 9):

The spinal centre situated between the first and fifth cervical segments of the cord is fixed and constant. As a general rule, the cells of this centre send their axons to the trapezius through both the spinal accessory and the cervical nerves. But sometimes there is a variation from this arrangement in that all the axons pass to the muscle in the spinal accessory, leaving the cervical nerves without function, as far as the trapezius is concerned. Under these circumstances, the motor impulses reach the trapezius exclusively through the spinal accessory, and section of it consequently means total palsy.

What can be done for operative paralysis of the spinal accessory nerve?

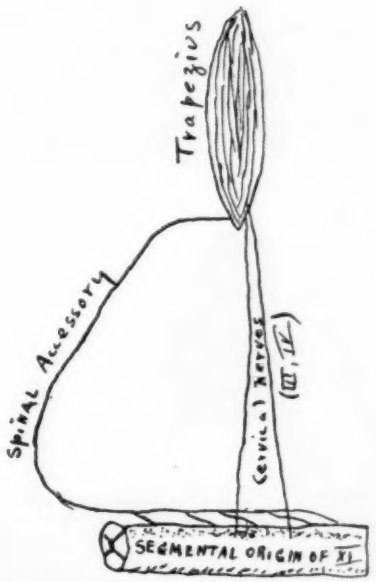


FIG. 9.—Scheme showing kindred segmental origin from cord of nerves supplying trapezius. The suprascapular nerve arises chiefly from the fifth cervical segment.

We have seen that, according to Mathews, the spinal accessory nerve can be accidentally divided and the injury not followed by shoulder drop. At times the nerve is intentionally severed at operation for the purpose of thorough extirpation of diseased lymph-nodes; here immediate suture of the severed ends is, of course, indicated. In Bailey's second case neurorrhaphy was performed about six weeks after the original operation. The cut ends of the nerve were found to be considerably separated—an inch or more. Within a few weeks from the suturing, the electric reaction improved.

What is to be the treatment when the trapezius branch of the spinal accessory nerve has been extensively resected, and the distal portion of the nerve, beneath the trapezius, can alone be found? The gap is too great for tubulization to be practicable, and nerve transplantation would be of doubtful

utility. For such a case the author suggests the following nerve-anastomosis operation. He would have attempted it in the present case, but for the presence of pus in the operative field.

The suprascapular nerve, which supplies the supra- and infraspinatus muscles, is in close relationship with the trapezius branch of the spinal accessory nerve as it enters the trapezius muscle. The suprascapular nerve is derived from the fifth and sixth cervical segments; the spinal portion of the spinal accessory is derived in part from the fifth cervical segment. It is proposed, then, to isolate the trapezius branch of the spinal accessory and the suprascapular nerve; to split the suprascapular nerve, and to anastomose the proximal stump of the split portion of the suprascapular nerve to the distal trapezius stump of the spinal accessory. This proposed nerve-anas-

FIG. 10.—Sketch showing author's proposed nerve anastomosis operation when there is a wide gap between ends of resected spinal accessory nerve. The suprascapular nerve is seen split above the retracted omohyoid muscle and the split end has been anastomosed to the distal end of the spinal accessory close to the border of the trapezius. The missing portion of the spinal accessory nerve is indicated by shading. The proximal portion of the latter appears from beneath the sternomastoid.

tomosis is at least as rational as the anastomosis of the spinal accessory with the facial nerve, and probably more rational, because of the close segmental relationship of the suprascapular and spinal accessory nerves.

DR. NATHANIEL GINSBURG said that it is not unusual to find in the dissecting room that the spinal accessory nerve occasionally breaks up into a plexus in the substance of the sternomastoid muscle, and fails to reform into the nerve trunk which generally leaves the upper posterior border of this muscle to pass to the trapezius muscle, and with the third and fourth cervical branches to form the subtrapezius plexus. It does not follow that division of the spinal accessory nerve will always be succeeded by shoulder drop, with anterior rotation, because the cervical nerves may suffice to innervate the muscle.

In the patient presented, it is apparent that bilateral division of the nerve

FIG. 11.

FIG. 12.

supply of both trapezii muscles has taken place, and that the injury is not confined to the spinal accessory nerves alone. It is not unlikely that the nerve supply of the rhomboideus major and minor has likewise been cut, since there is evidence of relaxation of these muscles. The introduction of a firm interscapular ligament of fascia lata would perhaps be of assistance in this case in bringing and maintaining the normal position of the scapulæ.

## MULTIPLE ENCHONDROMATA OF HAND

Dr. A. Bruce Gill presented a male child of two and a half years, whose X-ray photographs (Figs. 11 and 12) showed multiple enchondromata of the right hand only. Four metacarpals and nine phalanges are involved. X-ray plates of the other bones of the body show no evidence of enchondromata.

The child is healthy and well developed. He has never been ill with the exception of a furunculosis about a year ago. His parents are healthy and there is no family history of enchondromata, or hereditary deforming chondrodysplasia, as Ehrenfried terms it, for a period of at least three generations.

The child's parents first observed three or four months ago that his right hand seemed fatter, as they thought it, than it had been before. He has never complained of any pain or any discomfort in the hand, and he uses it for all ordinary purposes. Examination showed demonstrable enlargement of several of the phalanges and the metacarpals.

The subject of multiple enchondromata, or hereditary deforming chondrodysplasia, together with its literature, has been presented well in recent years by Boggs in the Transactions of the Association of American Physicians, Philadelphia, 1913, by Ehrenfried, Jour. A. M. A., May 15, 1915, by Ashhurst, Annals of Surgery, 1916, vol. 61, p. 167, by such others as Oberndorf, Clark and Atwood, Fragenheim, Schmidt, Lubarsch, Carman and Fisher, and others referred to in the above papers.

Various theories as to its etiology have been advanced, and many diseases such as syphilis, tuberculosis, and other infections, rhachitis, thyroid deficiency, trophic changes in the central nervous system have been suggested as causes. But the best opinion appears to be that it is a congenital condition due to abnormal *anlage* in the intermediary cartilage of the bones involved, and that frequently heredity plays a part. Certain cases said by Boggs to have been reported in the new-born, and the case here presented in a child two and a half years of age strongly indicate that the condition is truly a congenital one. The hereditary influence cannot always be traced, nor is the underlying cause of the congenital abnormality apparent.

supply of both trapezii muscles has taken place, and that the injury is not confined to the spinal accessory nerves alone. It is not unlikely that the nerve supply of the rhomboideus major and minor has likewise been cut, since there is evidence of relaxation of these muscles. The introduction of a firm interscapular ligament of fascia lata would perhaps be of assistance in this case in bringing and maintaining the normal position of the scapulæ.

## MULTIPLE ENCHONDROMATA OF HAND

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# CORRESPONDENCE

## TRAUMATIC ANEURISM OF THE TEMPORAL ARTERY

To the Editor of The Annals of Surgery:

Dear Sir:

In the Annals of Surgery for March, 1917, Dr. J. Shelton Horsley, in recording seven cases of traumatic aneurism of the temporal artery, states that, in the literature of the last twenty years, these are the only cases which can be found, the condition being apparently of some rarity. I therefore venture to append an epitome of a case recorded by myself in the *St. Bartholomew's Hospital Journal* of September, 1916. This case resembles, in many respects, that described by E. Holzwarth.

*Aneurism of right superficial temporal artery:* The patient was a young soldier. Four months previously a bullet entered the skin over the base of the right mastoid process, passed through the ear and emerged on the face, one inch in front of the external meatus.

*Present Condition.*—The right superficial temporal artery is dilated for two inches to a diameter of a quarter of an inch, being three times as large as its fellow. The dilatation commences at the upper border of the zygoma and extends upward. There is no paralysis of the upper branches of the facial nerve. Since the injury the hearing power of the right ear has greatly diminished, a watch being heard only at half an inch from the ear.

The symptoms produced are slight. The patient complains of vague pains in many areas of the scalp, and is conscious of the pulsation whenever he takes active exercise.

If severe symptoms develop, or if the aneurism increases, it is proposed to excise the dilated portion of the artery.

C. Hamilton Whiteford, M.R.C.S.

31st July, 1917.

5, Sussex Terrace, Plymouth, England.

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**To Contributors and Subscribers:**

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